RCRA Facility Investigation-Remedial Investigation/ Corrective Measures Study-Feasibility Study Report for the Rocky Flats Environmental Technology Site Appendix A – Comprehensive Risk Assessment

Volume 8 of 15
Lower Walnut Drainage Exposure Unit

This Report was prepared by Kaiser-Hill Company, L.L.C.
for the U.S. Department of Energy

June 2006

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ATTACHMENTS

ACRONYMS AND ABBREVIATIONS

µg/kg	microgram per kilogram
µg/L	microgram per liter
AEU	Aquatic Exposure Unit
AI	adequate intake
BAF	bioaccumulation factor
bgs	below ground surface
BZ	Buffer Zone
CAD/ROD	Corrective Action Decision/Record of Decision
CD	compact disc
CDH	Colorado Department of Health
CDPHE	Colorado Department of Public Health and Environment
cfs	cubic feet per second
CMS	Corrective Measures Study
CNHP	Colorado Natural Heritage Program
COC	contaminant of concern
CRA	Comprehensive Risk Assessment
DOE	U.S. Department of Energy
DQA	data quality assessment
DQO	data quality objective
DRI	dietary reference intake
ECOC	ecological contaminant of concern
ECOI	ecological contaminant of interest
ECOPC	ecological contaminant of potential concern
EcoSSL	ecological soil screening level

EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERA	Ecological Risk Assessment
ESL	ecological screening level
EU	Exposure Unit
FWS	U.S. Fish and Wildlife Service
HHRA	Human Health Risk Assessment
HQ	hazard quotient
HRR	Historical Release Report
IA	Industrial Area
IAG	Interagency Agreement
IDEU	Inter-Drainage Exposure Unit
IHSS	Individual Hazardous Substance Site
kg	kilogram
LOAEL	lowest observed adverse effect level
LOEC	lowest effects concentration
LWNEU	Lower Walnut Drainage Exposure Unit
LWOEU	Lower Woman Drainage Exposure Unit
MDC	maximum detected concentration
mg	milligram
mg/day	milligram per day
mg/kg	milligram per kilogram
mg/kg BW/day	milligram per kilogram receptor body weight per day
mg/L	milligram per liter
mL	milliliter

mL/day	milliliter per day
N/A	not applicable or not available
NFAA	No Further Accelerated Action
NNEU	No Name Gulch Drainage Exposure Unit
NOAEL	no observed adverse effect level
NOEC	No observed effect concentration
OU	Operable Unit
PAC	Potential Area of Concern
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCB	polychlorinated biphenyl
pCi	picocurie
pCi/g	picocuries per gram
pCi/L	picocuries per liter
PCOC	potential contaminant of concern
PMJM	Preble's meadow jumping mouse
PRG	preliminary remediation goal
QAPjP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
RCEU	Rock Creek Drainage Exposure Unit
RCRA	Resource Conservation and Recovery Act
RDA	recommended daily allowance
RDI	recommended daily intake
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RI/FS	Remedial Investigation/Feasibility Study

SAP	Sampling and Analysis Plan
SCM	Site Conceptual Model
tESL	threshold ESL
TRV	toxicity reference value
UBC	Under Building Contamination
UCL	upper confidence limit
UL	upper limit daily intake
UT	uncertain toxicity
UTL	upper tolerance limit
UWNEU	Upper Walnut Drainage Exposure Unit
VOC	volatile organic compound
WBEU	Wind Blown Area Exposure Unit
WRV	wildlife refuge visitor
WRW	wildlife refuge worker

EXECUTIVE SUMMARY

This report presents the Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) for the 390-acre Lower Walnut Drainage Exposure Unit (EU) (LWNEU) at the Rocky Flats Environmental Technology Site (RFETS). The purpose of this report is to assess potential risks to human health and ecological receptors posed by exposure to contaminants of concern (COCs) and ecological contaminants of potential concern (ECOPCs) remaining at the LWNEU after completion of accelerated actions at RFETS.

Results of the COC selection process for the HHRA indicate that no COCs were selected and there are no significant human health risks from RFETS-related operations at the LWNEU. As a result, potential health risks for the wildlife refuge worker (WRW) and wildlife refuge visitor (WRV) are expected to be within the range of background risks. The estimated cancer risks for the WRW and WRV associated with potential exposure to background levels of naturally occurring metals in surface soil/surface sediment are both approximately 2E-06. The estimated noncancer hazard indices associated with potential exposure to background levels of metals in surface soil/surface sediment are approximately 0.3 for the WRW and 0.1 for the WRV.

The ECOPC identification process streamlines the ecological risk characterization by focusing the assessment on ecological contaminants of interest (ECOIs) that are present in the LWNEU. The ECOPC identification process is described in the Comprehensive Risk Assessment (CRA) Methodology (U.S. Department of Energy [DOE] 2005a) and additional details are provided in Appendix A, Volume 2 of the Remedial Investigation/Feasibility Study (RI/FS) Report. Only one ECOI in surface soil (4,4'-DDT) was identified as an ECOPC for representative populations of non-Preble's meadow jumping mouse (PMJM) receptors. No ECOPCs were identified for individual PMJM receptors in surface soil. No ECOPCs were identified in subsurface soil for burrowing receptors.

ECOPC/receptor pairs were evaluated in the risk characterization using conservative default exposure and risk assumptions as defined in the CRA Methodology. Tier 1 and Tier 2 EPCs were used in the risk characterization: Tier 1 EPCs are based on the upper confidence limits of the arithmetic mean concentration for the EU data set and Tier 2 EPCs are calculated using a spatially-weighted averaging approach. If needed, a refinement of the exposure and risk models based on chemical-specific uncertainties associated with the initial default exposure models, provide a refined estimate of potential risk.

Using Tier 1 EPCs and default exposure and risk assumptions, NOAEL HQs ranged from 8 (4,4'-DDT/American kestrel) to 22 (4,4'-DDT/mourning dove-insectivore). NOAEL HQs also ranged from 8 (4,4'-DDT/American kestrel) to 22 (4.4'-DDT/mourning dove-insectivore) using Tier 2 EPCs and default exposure and risk assumptions.

Both ECOPC/receptor pairs (4,4'-DDT/American kestrel and 4,4'-DDT/mourning dove – insectivore) had LOAEL HQs less than 1 using either Tier 1 or Tier 2 EPCs and the default assumptions used in the risk calculations.

Based on the default calculations, site-related risks are likely to be low for the ecological receptors evaluated in the LWNEU. In addition, data collected on wildlife abundance and diversity indicate that wildlife species richness remains high at RFETS. There are no significant risks to ecological receptors or high levels of uncertainty with the data and, therefore, no ecological contaminants of concern (ECOCs) for the LWNEU.

1.0 LOWER WALNUT DRAINAGE EXPOSURE UNIT

This volume of the Comprehensive Risk Assessment (CRA) presents the Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) for the Lower Walnut Drainage Exposure Unit (EU) (LWNEU) at Rocky Flats Environmental Technology Site (RFETS) (Figure 1.1).

The HHRA and ERA methods and selection of receptors are described in detail in the Final Comprehensive Risk Assessment (CRA) Work Plan and Methodology (U.S. Department of Energy [DOE] 2005a), hereafter referred to as the CRA Methodology. A summary of the risk assessment methods, including updates made in consultation with the regulatory agencies, are summarized in Appendix A, Volume 2, Section 2.0 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation/Corrective Measures Study (CMS)-Feasibility Study (RI/FS) Report (hereafter referred to as the RI/FS Report).

The anticipated future land use of RFETS is a wildlife refuge. Consequently, two human receptors, a wildlife refuge worker (WRW) and a wildlife refuge visitor (WRV), are evaluated in this risk assessment consistent with this land use. A variety of representative terrestrial and aquatic receptors are evaluated in the ERA. The assessment of the LWNEU includes all terrestrial receptors named in the CRA Methodology, including the Preble's meadow jumping mouse (PMJM), a federally listed threatened species present at RFETS.

1.1 Lower Walnut Drainage Exposure Unit Description

This section provides a brief description of the LWNEU, including its location at RFETS, historical activities in the area, topography, surface water features, vegetation, and ecological resources. A more detailed description of these features and additional information regarding the geology, hydrology, and soil types at RFETS is included in Section 2.0, Physical Characteristics of the Study Area, of the RI/FS Report. This information is also summarized in Appendix A of Volume 2 of the RI/FS Report.

The Historical Release Report (HRR) and its annual updates provide descriptions of known or suspected releases of hazardous substances that occurred at RFETS. The original HRR (DOE 1992) organized these known or suspected historical sources of contamination as Individual Hazardous Substance Sites (IHSSs), Potential Areas of Concern (PACs), or Under Building Contamination (UBC) sites (hereafter collectively referred to as historical IHSSs). Individual historical IHSSs and groups of historical IHSSs were also designated as Operable Units (OUs). Over the course of cleanup under the 1991 Interagency Agreement (IAG 1991) and the 1996 Rocky Flats Cleanup Agreement (RFCA 1996), the U.S. Department of Energy (DOE) has thoroughly investigated and characterized contamination associated with these historical IHSSs. Historical IHSSs have been dispositioned through appropriate remedial actions or by determining that No Further Accelerated Action (NFAA) is required, pursuant to the applicable IAG and RFCA requirements. Some OUs have also been dispositioned in

accordance with an OU-specific Corrective Action Decision/Record of Decision (CAD/ROD).

A more detailed description of the regulatory agreements and the investigation and cleanup history under these agreements is contained in Section 1.0 of the RI/FS Report. Section 1.4.3 of the RI/FS Report describes the accelerated action process, while Table 1.4 of the RI/FS Report summarizes the disposition of all historic IHSSs at RFETS. The 2005 Annual Update to the HRR (DOE 2005b) provides a description of the potential contaminant releases for each IHSS, and any interim response to the releases; identification of potential contaminants based on process knowledge and site data; data collection activities; accelerated action activities (if any); and the basis for recommending NFAA.

The LWNEU is located within the Buffer Zone (BZ) OU, north-east of the Industrial Area (IA) that was used for RFETS operations (Figure 1.1). According to the 2005 Annual Update to the HRR (DOE 2005b), the LWNEU contains one IHSS (Table 1.1), the Flume Pond (NE-142.12), also referred to as Retention Pond A-5. The Flume Pond is located on Walnut Creek immediately west of and upstream from Indiana Street (Figure 1.2). The Flume Pond was approved for NFAA as documented in the 2005 Annual Update to the Historical Release Report (DOE 2005b),. In general, NFAs and NFAAs are based on human health exposures. The intent of the ecological component of the CRA is to evaluate any potential risk to ecological receptors associated with the residual contamination at the site following the accelerated actions.

1.1.1 Exposure Unit Characteristics and Location

The 390-acre LWNEU is located on the northeastern perimeter of RFETS (Figure 1.1) and has several distinguishing features:

- The LWNEU is located within the BZ OU and outside the Industrial Area (IA) that was used historically for manufacturing and processing operations at RFETS.
- Documented historical source areas are limited within the LWNEU boundaries. The EU contains one historical IHSS and is located topographically and hydraulically downgradient relative to the IA and the terminal ponds. Winds, although variable, are predominately from the northwest. Therefore, the LWNEU is not in a predominantly downwind direction.
- The LWNEU is immediately downstream of the confluence of North and South Walnut Creeks and No Name Gulch, which forms Walnut Creek. Surface water releases from the A- and B-series ponds pass through Walnut Creek.
- The LWNEU is bound by the Inter-Drainage EU (IDEU), No Name Gulch Drainage EU (NNEU), and Upper Walnut Drainage EU (UWNEU) to the west, and the Wind Blown Area EU (WBEU) to the south (Figure 1.1). Land north and east of the LWNEU, outside of the RFETS boundary, is existing open space.

1.1.2 Topography and Surface Water Hydrology

The LWNEU is located within the easternmost portion of the Walnut Creek drainage basin at RFETS and includes portions of Dry Creek, Upper Church Ditch, McKay Ditch, and Walnut Creek (Figures 1.2 and 1.3).

Dry Creek, located in the northwestern part of the LWNEU, is usually dry, with flow only after sufficiently large precipitation events trigger runoff.

Upper Church Ditch runs along the northern boundary of the LWNEU and is owned and operated by the City of Broomfield. Upper Church Ditch is a seldom-used, though still-active water conveyance structure that diverts water from Coal Creek to Upper Church Lake and the Great Western Reservoir.

McKay Ditch, which is also owned and operated by the City of Broomfield, enters the LWNEU from the west and diverts water from the South Boulder Diversion Canal to the Great Western Reservoir for irrigation. McKay Ditch is generally dry, except in the spring. The ditch runs from west to east across the northern BZ, and is hydrologically isolated from the former IA. McKay Ditch was formerly a tributary to Walnut Creek within the LWNEU. However, in 1999, an underground pipeline was constructed in the northeast BZ to reroute McKay Ditch water and prevent it from co-mingling with water in Walnut Creek discharged from the RFETS retention ponds (see Figures 1.2 and 1.3). The pipeline daylights on the east side of Indiana Street. This configuration allows the City of Broomfield to divert water from either Coal Creek or the South Boulder Diversion Canal (both west of RFETS) directly into the Great Western Reservoir, where the water is stored by the City of Broomfield to be used for irrigation.

Downstream from Terminal Ponds A-4 and B-5, North and South Walnut Creeks merge to form Walnut Creek. All water flowing off site via Walnut Creek passes through the Flume Pond. When buildings and pavement existed in the IA, the mean annual discharge volume measured at gaging station GS03 (at Walnut Creek and Indiana Street) was approximately 479 acre-feet per year (based on flow records from October 1, 1996, to September 20, 2003). The peak flow rate measured during the same period was 56.5 cubic feet per second (cfs). Flow rates and volume in Walnut Creek following closure are expected to be substantially reduced compared to flows when the IA existed.

1.1.3 Flora and Fauna

Many of the plant communities found at RFETS are present within the LWNEU, as shown on a vegetation map for the LWNEU in Figure 1.4. Mesic mixed grassland is the dominant vegetation community. Other plant communities comprise xeric tallgrass prairie and xeric needle and thread grasslands on the pediment; short upland shrubland and seep-fed wetlands on hillsides; and riparian woodlands and wetlands on the valley floor. Reclaimed grasslands are found where projects creating surface disturbances (such as the McKay Ditch underground pipeline) have been reseeded.

The mesic-mixed grassland is distinguished at RFETS by such plant species as western wheatgrass (*Agropyron smithii*), blue grama *(Bouteloua gracilis)*, side-oats grama

(Bouteloua curtipendula), prairie junegrass *(Koeleria pyramidata)*, Canada bluegrass, Kentucky bluegrass, green needlegrass *(Stipa virigula)*, and little bluestem (*Andropogon scoparius*). Land that is within the LWNEU was heavily grazed during past land use. However, since the purchase of land by DOE, grazing within the EU has not occurred in decades and plant communities have nearly returned to pre-grazed conditions. Mesic grasslands are important to wildlife, and grassland conditions are good on the eastern side of RFETS, including the LWNEU; however, weeds have degraded grasslands in some areas (PTI 1997).

No federally listed plant species are known to occur at RFETS. However, the xeric tallgrass prairie, tall upland shrubland, riparian shrubland, and plains cottonwood riparian woodland communities are considered rare and sensitive plant communities by the Colorado Natural Heritage Program (CNHP). RFETS also supports populations of four rare plant species that are listed as rare or imperiled by the CNHP. These include: forktip three-awn (*Aristida basiramea*), mountain-loving sedge (*Carex oreocharis*), carrionflower greenbriar (*Smilax herbacea var. lasioneuron*), and dwarf wild indigo (*Amorpha nana*).

As noted above, the CNHP considers the riparian shrubland found in LWNEU and throughout RFETS as rare and declining plant communities across the Great Plains. These plant communities provide habitat for a disproportionate number of species given their size. The presence of woody vegetation (i.e., trees and shrubs) in an arid environment provides vital habitat to songbirds, raptors, amphibians, and mammals as well as many invertebrate groups.

Numerous animal species have been observed at RFETS and most of these species are expected to be present in the LWNEU. Common large and medium-sized mammals likely to live or frequent the LWNEU include mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), coyote (*Canis latrans*), raccoon (*Procyon lotor*), and desert cottontail (*Sylvilagus audubonii*). The most common reptile observed at RFETS is the western prairie rattlesnake (*Crotalis viridus*) and the most common amphibian is the boreal chorus frog (*Pseudacris tryseriatus*). Common birds include red-winged blackbird (*Agelaius phoeniceus*), song sparrow (*Melospiza melodia*), meadowlark (*Sturnella neglecta*), and vesper sparrow (*Pooecetes gramineus*). The most common small mammal species include deer mouse (*Peromyscus maniculatus*), prairie vole (*Microtus ochrogaster*), meadow vole (*Microtus pennsylvanicus*), and different species of harvest mice (*Reithrodontomys sp*.).

RFETS supports two wildlife species listed as threatened or endangered species under the Endangered Species Act (USFWS 2005). The PMJM (*Zapus hudsonius preblei*) and the bald eagle (*Haliaeetus leucocephalus*) are listed as threatened species. The PMJM is a federally listed threatened species found at RFETS. The preferred habitat for the PMJM is the riparian corridors bordering RFETS' streams, ponds, and wetlands with an adjacent thin band of upland grasslands. The bald eagle occasionally forages at RFETS although no nests have been identified on site.

There are also a number of wildlife species that have been observed at RFETS that are species of concern by the State of Colorado (USFWS 2005). The plains sharp-tailed grouse (*Tympanuchus phasianellus jamesii*) is listed as endangered by the State and has been observed infrequently at RFETS. The western burrowing owl (*Athene cunicularia hypugea*) is listed as threatened by the State and is a known resident or regular visitor at RFETS. The ferruginous hawk (*Buteo regalis*), American peregrine falcon (*Falco peregrinus*), and the northern leopard frog (*Rana pipiens*) are listed as species of special concern by the State and are considered known residents or regular visitors at RFETS. The following species are listed as species of special concern and are observed infrequently at RFETS: greater sandhill crane (*Grus canadensis tibida*), long-billed curlew (*Numenius americanus*), mountain plover (*Charadrius montanus*), and the common garter snake (*Thamnophis sirtalis*).

More information on the plant communities and animal species that exist within RFETS is provided in Section 2.0 of the RI/FS Report.

1.1.4 Preble's Meadow Jumping Mouse Habitat within Lower Walnut Exposure Unit

LWNEU supports habitat for the federally protected PMJM which have been captured within LWNEU for over a decade (DOE 1995; K-H 1997a, 2000a, 2000b, 2002a and 2002b). Lower Walnut Creek supports approximately 13 (±1) individuals in the middle and lower portions of the EU (K-H 2000a, 2000b). Although habitat is found along streams throughout LWNEU, few PMJM have been found in the western portion of the EU approaching the terminal dams. PMJM observed in the EU do not travel upstream to UWNEU or NNEU, suggesting PMJM in the LWNEU are isolated from other subpopulations found on RFETS.

Sitewide PMJM habitat patches were developed in an effort to characterize habitat discontinuity and provide indications of varying habitat quality. The locations of the PMJM patches within the LWNEU are depicted in Figure 1.5. These patches aid in the evaluation of surface soil within PMJM habitat, giving a spatial understanding of areas that may be used by individual or subpopulations of PMJM. More detail on the methodology of creating sitewide PMJM habitat patches can be found in Appendix A, Volume 2, Section 3.2 of the RI/FS Report.

PMJM habitat within the LWNEU was divided into three habitat patches, each containing habitat capable of supporting at least several PMJM individuals. The patches vary in size and shape dependent on their location within the Lower Walnut Creek drainage as well as the discontinuity or habitat quality of surrounding patches. The following is a brief discussion of the three patches within the LWNEU (Figure 1.5) and the reasons they are considered distinct:

- Patch #10 – This patch contains marginal habitat along McKay Ditch. Vegetation within the patch is comprised of riparian woodlands and wet meadows. Willow riparian shrubs, cattails, and reclaimed grasslands are also present. The boundaries for this patch correspond to habitat boundaries mapped earlier by the

U.S. Fish and Wildlife Service (USFWS 2005). Although the proper vegetation characteristics are present, McKay Ditch rarely contains water and, therefore, habitat quality is low. No PMJM have been found in this patch. Patch #10 also includes a section of habitat that extends into the NNEU.

- Patch #13 – This patch is located at the confluence of North and South Walnut Creeks and contains habitat below the terminal ponds (Pond A-4 and B-5). The vegetation is dominated by short marsh and narrow creek channels that are often dry. A few trees are present, but willow shrubs are absent. The upstream boundary for this patch is where habitat ends (USFWS 2005) and the downstream margin is where contiguous riparian vegetation begins (K-H 1997b). Although all the habitat components are present, the narrow incised channels are of lower-quality habitat compared to areas downstream. No PMJM have been found in this patch. Patch #13 also includes a small section of habitat that extends into the UWNEU.

- Patch #14 – This patch contains higher-quality habitat compared to Patch #13 and supports PMJM. The upstream boundary of the patch is where contiguous riparian woodland vegetation begins, and the downstream periphery is marked by the RFETS boundary. Shrubby riparian vegetation with a thick understory of herbaceous growth is present in a contiguous section until the creek's confluence with the Flume Pond. Large expanses of snowberry shrubs are found between riparian vegetation and mesic grasslands. It has been estimated that this patch can support approximately 13 PMJM (K-H 2000a, 2000b).

1.1.5 Data Description

Data have been collected at RFETS under regulatory agency-approved Work Plans, Sampling and Analysis Plans (SAPs), and Quality Assurance Project Plans (QAPjPs) to meet data quality objectives (DQOs) and appropriate U.S. Environmental Protection Agency (EPA) and Colorado Department of Public Health and Environment (CDPHE) guidance. Surface soil, subsurface soil, surface sediment, subsurface sediment, and groundwater samples were collected from the LWNEU. The data set for the CRA was prepared in accordance with data processing steps described in Appendix A, Volume 2, Attachment 2 of the RI/FS Report. Surface soil/surface sediment, subsurface soil/subsurface sediment, surface soil, and subsurface soil are the media evaluated in the HHRA and ERA (Table 1.2). The sampling locations for these media are shown on Figures 1.6 and 1.7, and data summaries for detected analytes in each medium are provided in Tables 1.3 through 1.7. Potential contaminants of concern (PCOCs) and ecological contaminants of interest (ECOIs) that were analyzed for but not detected, or were detected in less than 5 percent of the samples, are presented in Attachment 1. Detection limits are compared to preliminary remediation goals (PRGs) and ecological screening levels (ESLs) and discussed in Attachment 1 (Tables A1.1 through A1.4). Only data from June 1991 to the present are used in the CRA because these data meet the approved analytical Quality Assurance/Quality Control (QA/QC) requirements.

In accordance with the CRA Methodology, only data collected on or after June 28, 1991, and data for subsurface soil and subsurface sediment samples with a start depth less than

or equal to 8 feet below ground surface (bgs) are used in the CRA. Subsurface soil and subsurface sediment data are limited to this depth because it is not anticipated that the WRW or burrowing animals will dig to deeper depths. A detailed description of data storage and processing methods is provided in Appendix A, Volume 2 of the RI/FS Report. The CRA analytical data set for the LWNEU is provided on a compact disc (CD) presented in Attachment 6. The CD includes the data used in the CRA as well as data not considered useable based on criteria presented in Appendix A, Volume 2 of the RI/FS Report.

The sampling data used for the LWNEU HHRA and ERA are as follows:

- Combined surface soil/surface sediment data (HHRA);
- Combined subsurface soil/subsurface sediment data (HHRA);
- Surface soil data (ERA); and,
- Subsurface soil data (ERA).

The data for these media are briefly described below.

In addition, because ecological contaminants of potential concern (ECOPCs) were identified for soil in this EU, surface water data were used in the ERA as part of the overall intake of ECOPCs by ecological receptor. The surface water data used in the ERA are summarized in Table 8.5. Surface water and sediment are assessed for ecological receptors on an Aquatic Exposure Unit (AEU) basis in Appendix A, Volume 15B of the RI/FS Report. An assessment of the surface water, groundwater-to-surface water, and volatilization pathways for human health are presented in Appendix A, Volume 2 of the RI/FS Report.

Surface Soil/Surface Sediment

The combined surface soil/surface sediment data set for the LWNEU consists of up to 81 samples that were analyzed for inorganics (29 samples), organics (15 samples), and radionuclides (81 samples) (Table 1.2). The data include sediment samples collected to depths down to 0.5 feet below ground surface (bgs). The surface soil sampling density is highest at and near the Flume Pond, but the entire site was covered during the 30-acre sampling. For the grid sampling, five individual samples were collected and composited from each 30-acre cell, one from each quadrant and one in the center, as described in the CRA SAP Addendum 04-01 (DOE 2004). Sampling locations on Figure 1.6 denoted with D or E, followed by a second letter (such as P or V, for example), identify 30-acre grid samples. The sampling locations for surface soil and surface sediment are shown on Figure 1.6. All sample locations within the LWNEU were not necessarily analyzed for all analyte groups (see Table 1.3). Twenty-one surface sediment samples were collected from the LWNEU, two from McKay Ditch and the remainder from Walnut Creek.

The data summary for detected analytes in surface soil/surface sediment for the LWNEU is presented in Table 1.3. Detected analytes included representatives from the inorganics, organics, and radionuclides analyte groups.

Subsurface Soil/Subsurface Sediment

The combined subsurface soil/subsurface sediment data set for the LWNEU consists of up to 20 samples analyzed for inorganics, 21 for organics, and 17 for radionuclides (Table 1.2). The data include subsurface sediment samples with a starting depth less than or equal to 8 feet bgs and an ending depth below 0.5 feet. The sampling locations for subsurface soil and subsurface sediment are shown on Figure 1.7. All sample locations within the LWNEU were not necessarily analyzed for all analyte groups (see Table 1.4).

The data summary for subsurface soil/subsurface sediment in the LWNEU is presented in Table 1.4. Detected analytes included representatives from the inorganics, organics, and radionuclides analyte groups.

Surface Soil

Data meeting the CRA requirements are available for up to 57 surface soil samples collected in the LWNEU that were analyzed for inorganics (23 samples), organics (12 samples), and radionuclides (57 samples) (Table 1.2). The surface soil sampling locations for the LWNEU are shown on Figure 1.6. All sample locations within the LWNEU were not necessarily analyzed for all analyte groups (see Tables 1.5 and 1.6). The surface soil sampling density is highest at and near the Flume Pond, but the entire site was covered during the 30-acre sampling. For the grid sampling, five individual samples were collected and composited from each 30-acre cell, one from each quadrant and one in the center, as described in the CRA SAP Addendum 04-01 (DOE 2004). Sampling locations on Figure 1.6 denoted with D or E, followed by a second letter (such as P or V, for example), identify 30-acre grid samples.

The data summary for detected analytes in LWNEU surface soil is presented in Table 1.5. The data summary for the detected analytes for those samples within designated PMJM habitat is presented in Table 1.6. Radionuclides, organics, and inorganics were detected in LWNEU surface soil samples. A summary of analytes that were either not detected, or detected in less than 5 percent of samples in surface soil in the LWNEU, is presented and discussed in Attachment 1.

Subsurface Soil

The subsurface soil data set for the LWNEU consists of up to 16 samples. All 16 samples were analyzed for organics, 14 for inorganics, and 11 for radionuclides (Table 1.2). Subsurface soil sampling locations are shown on Figure 1.7. All sample locations within the LWNEU were not necessarily analyzed for all analyte groups (see Table 1.7). Almost all subsurface soil sampling locations are at or near IHSS 142.12. Subsurface soil samples used in the CRA are defined in the CRA Methodology as soil samples with a starting depth less than or equal to 8 feet bgs and an ending depth below 0.5 feet.

The data summary for detected analytes in subsurface soil for the LWNEU is presented in Table 1.7. Subsurface soil samples were analyzed for inorganics, organics, and radionuclides, and representatives from all three analyte groups were detected.

1.2 Data Adequacy Assessment

A data adequacy assessment was performed to determine whether the available data set discussed in the previous section is adequate for risk assessment purposes. The data adequacy assessment rules are presented in the CRA Methodology, and a detailed data adequacy assessment for the data used in the CRA is presented in Appendix A, Volume 2, Attachment 3 of the RI/FS Report. The adequacy of the data was assessed by comparing the number of samples for each analyte group in each medium as well as the spatial and temporal distributions of the data to data adequacy guidelines. If the data do not meet the guidelines, other lines of evidence (e.g., information on potential historical sources of contamination, migration pathways, and the concentration levels in the media) are examined to determine if it is possible to make risk management decisions given the data limitations.

The findings from the data adequacy assessment applicable to all EUs are as follows:

- The radionuclide and inorganic surface soil data are adequate for the purposes of the CRA.

- For herbicides and pesticides, although the existing surface soil and sediment data may not meet the minimal data adequacy guidelines for each EU, there is considerable site-wide data, and pesticides and herbicides are infrequently detected at low concentrations, generally below PRGs and ESLs. This line of evidence indicates that it is possible to make risk management decisions without additional sampling for these analyte groups

- For dioxins, although the existing surface soil and sediment data do not meet the minimal data adequacy guidelines for each EU, sample locations were specifically targeted for dioxin analysis at historical IHSSs in and near the former Industrial Area where dioxins may have been released based on process knowledge. Some of the dioxin concentrations at the historical IHSSs exceed the PRG and/or ESL. Additional samples were collected in targeted locations that represented low-lying or depositional areas where dioxin contamination may have migrated via runoff from these specific IHSSs. Results indicated that dioxin concentrations are not above the minimum ESL in sediment and dioxins are not detected in surface water. Therefore, although the existing data do not meet the minimal data adequacy guidelines for each EU/AEU, it is possible to make risk management decisions without additional sampling. However, unlike pesticides and herbicides where there is considerably more site-wide data, there is greater uncertainty in the overall risk estimates because fewer samples were collected at the site for dioxins.

- Subsurface soil contamination is largely confined to historical IHSSs (that is, areas of known or suspected historical releases). These areas have been

characterized to understand the nature and extent of potential releases. For historical IHSSs where subsurface soil samples were not collected for an analyte group, the presence of this type of subsurface contamination was not expected based on process knowledge. Therefore, the existing subsurface soil data are adequate for the purposes of the CRA.

The findings from the data adequacy report applicable to the LWNEU are as follows:

- For surface soil, data for at least five samples exists for each organic analyte group, except PCBs (four samples). For surface soil/surface sediment, data for at least five samples exist for each organic analyte group. Although there are only four surface soil samples for PCBs, these compounds are not expected to be contaminants in surface soil in this EU. First, the Flume Pond (IHSS 142.12) is the only historical IHSS in the EU. It was used for Walnut Creek flow measurements and is not expected to be a source of contamination for the LWNEU. Second, because the dominant contaminant migration pathway from historical sources in the Industrial Area (former transformer sites) is runoff and transport by water into Walnut Creek, i.e., PCBs are most likely to be present in the sediment of Walnut Creek if they are present at all. The data indicate PCBs are present in the sediment of the A- and B-series ponds upgradient of the LWNEU, but are not present in the sediment of Walnut Creek within the LWNEU. Furthermore, PCBs are not detected in LWNEU surface soil. Therefore, although the existing PCB data do not meet the minimal data adequacy guidelines for the EU, these lines of evidence indicate PCBs are not likely to be present in surface soil for this EU, and it is possible to make risk management decisions without additional sampling.

- No surface soil or sediment samples were collected for dioxins in the LWNEU. Although this does not meet the minimal data adequacy guideline, as noted above, dioxins are not expected to have been released in SEEU and it is possible to make risk management decisions without additional sampling.

- Surface soil sample locations for the VOCs, SVOCs, and PCBs tend to be clustered in the southern portion of the EU, with several samples located near the Flume Pond. With the addition of the sediment data, the sample locations are more evenly distributed throughout the EU, although data are still lacking for the northern portion of the EU. However, because the existing data indicate that concentrations of VOCs, SVOCs, and PCBs are either non-detected or less than the PRGs/ESLs, and there are no potential historical sources within the EU or significant contaminant transport pathways to LWNEU surface soil from potential historical sources in the Industrial Area, concentration gradients should not be present and the data should be representative of the entire EU. Accordingly, it is possible to make risk management decisions without additional sampling.

- The number of samples within the PMJM habitat patches for each analyte group varies from zero to 8, with patch #14 having the greatest number of samples. Patch # 14 meets the data adequacy guideline of 3 or more samples, except for

PCBs, where there are no samples. However, as discussed for surface soil and surface soil/surface sediment, PCBs are not expected to be present in surface soil in the PMJM habitat. Patches #10 and #13 do not meet the data adequacy guideline for any analyte groups (except patch #13 has three samples for radionuclides). Because of the absence of potential historical sources within the EU for contamination, and the remote location of the LWNEU PMJM habitat from potential historical sources in the Industrial Area, concentration gradients should not be present and the data for habitat patch #14 should be representative of the other habitat patches. Also, using these same lines of evidence, surface soil data for the PMJM habitat patches can be aggregated for the purpose of conducting a statistical background comparison. Therefore, although the data do not meet the minimal data adequacy guidelines for the EU PMJM patches, it is possible to make risk management decisions without additional sampling.

- There are data for at least 5 surface water samples for radionuclides, metals, VOCs, and SVOCs, but only 4 samples for PCBs. However, PCBs were not detected in surface water in the LWNEU and were not detected in surface water in the upgradient A- and B-series ponds. Therefore, although the LWNEU PCB data do not meet the minimal data adequacy guidelines, the absence of detectable levels of these compounds in surface water within the EU and in the upgradient ponds suggest they are not likely to be present in surface water in the EU, and it is possible to make risk management decisions without additional sampling.

- The surface water sampling locations are well distributed throughout the LWNEU, and thus meet the data adequacy guideline for spatial representativeness.

- Although current data exist for radionuclides and metals, there are no surface water data from 2001 to the present for any of the organic analyte groups. With respect to the organic analyte groups, the pre-2001 data indicate that the organics are either less than the PRGs/ESLs or non-detected. There are also no sources for organic contamination within the LWNEU. Therefore, these lines of evidence indicate concentration trends for the constituents in these analyte groups are unlikely, and it is possible to make risk management decisions without additional sampling.

- For analytes not detected or detected in less than 5 percent of the samples in surface soil/surface sediment, 3 analytes have detection limits that exceed PRGs, however, the magnitude of the exceedances are relatively low, i.e., the maximum detection limits are of the same order of magnitude as the PRGs. All detection limits are below the PRGs/ESLs for subsurface soil/subsurface sediment and subsurface soil samples There are 16 analytes in surface soil where some percent of the detection limits exceed the lowest ESL. However, these analytes that have detection limits that exceed the lowest ESLs contribute only minimal uncertainty to the overall risk estimates because either only a small fraction of the detection limits are greater than the lowest ESL, or professional judgment indicates they are not likely to be ECOPCs in LWNEU surface soil even if detection limits had been

lower. This includes PCBs as noted above. Although some of the analytes would present a potential for adverse ecological effects if they were detected at their maximum detection limits, because they are not expected to have been ECOPCs in LWNEU surface soil, uncertainty in the overall risk estimates is low (see Attachment 1 for a more detailed discussion).

1.3 Data Quality Assessment

A Data Quality Assessment (DQA) of the LWNEU data was conducted to determine whether the data were of sufficient quality for risk assessment use. The DQA is presented in Attachment 2, and an evaluation of the entire RFETS data set is presented in Appendix A, Volume 2 of the RI/FS Report. The quality of the laboratory results were evaluated for compliance with the CRA Methodology data quality objectives (DQOs) through an overall review of precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters. This review concluded that the data are of sufficient quality for use in the CRA, and the CRA DQOs have been met.

2.0 SELECTION OF HUMAN HEALTH CONTAMINANTS OF CONCERN

The human health contaminant of concern (COC) screening process is described in Section 4.4 of the CRA Methodology and summarized in Appendix A, Volume 2 of the RI/FS Report (Section 2.2).

The human health COC selection process was conducted for surface soil/surface sediment and subsurface soil/subsurface sediment in the LWNEU. Results of the COC selection process are summarized below.

2.1 Contaminant of Concern Selection for Surface Soil/Surface Sediment

Detected PCOCs in surface soil/surface sediment samples (Table 1.3) are screened in accordance with the CRA Methodology to identify the COCs.

2.1.1 Surface Soil/Surface Sediment Cation/Anion and Essential Nutrient Screen

The major cations and anions that do not have toxicity criteria are eliminated from assessments in surface soil/surface sediment in accordance with the CRA Methodology.

The essential nutrient screen for analytes detected in surface soil/surface sediment is presented in Table 2.1. The screen includes PCOCs that are essential for human health and do not have toxicity criteria available. Table 2.1 shows the maximum detected concentrations (MDCs) for essential nutrients, daily intake estimates based on the MDCs, and dietary reference intakes (DRIs). The DRIs are identified in the table as recommended daily allowances (RDAs), recommended daily intakes (RDIs), adequate intakes (AI), and upper limit daily intakes (ULs). The estimated daily maximum intakes based on the nutrients' MDCs and a surface soil/surface sediment ingestion rate of 100 milligrams per day (mg/day) are less than the DRIs. Therefore, these PCOCs were not further evaluated as COCs for surface soil/surface sediment.

2.1.2 Surface Soil/Surface Sediment Preliminary Remediation Goals Screen

Table 2.2 compares the MDCs and upper confidence limits (UCLs) to the WRW PRGs for each PCOC. If the MDC and the UCL are greater than the PRG, the PCOC is retained for further screening; otherwise, it is not further evaluated. Arsenic, cesium-134, and cesium-137, in surface soil/surface sediment had MDCs and UCLs that exceeded the PRGs and were retained as PCOCs. The MDC for radium-228 exceeded the PRG and was retained as a PCOC. The UCL for radium-228 in surface soil/surface sediment was not calculated based on the number of samples available.

PRGs were not available for several PCOCs in surface soil/surface sediment. Analytes without PRGs are listed on Table 2.2 and their effect on the conclusions of the risk assessment results is discussed in the uncertainty section (Section 6.0).

2.1.3 Surface Soil/Surface Sediment Detection Frequency Screen

Arsenic was detected in more than 5 percent of surface soil/surface sediment samples and, therefore, was retained for further evaluation in the COC screen (Table 1.3). A detection frequency screen was not performed for cesium-134, cesium-137, and radium-228 in surface soil/surface sediment because all reported values for radionuclides are considered detects.

2.1.4 Surface Soil/Surface Sediment Background Analysis

Results of the background statistical comparison for arsenic, cesium 134, and cesium-137 are presented in Table 2.3 and discussed in Attachment 3. Box plots for arsenic, cesium-134, and cesium-137 (both the LWNEU and background data sets) are provided in Attachment 3. Arsenic is the only PCOC that was statistically greater than background at the 0.1 significance level, and it is evaluated further in the professional judgment section. A background comparison could not be conducted for radium-228 because only one analysis was available for surface soil/surface sediment in the LWNEU. Radium-228 was also retained for professional judgment.

The results of the statistical comparisons indicate that site concentrations of cesium-134 and cesium-137 are not greater than those for background. Therefore, these analytes were not further evaluated as PCOCs in surface soil/surface sediment in the LWNEU.

2.1.5 Surface Soil/Surface Sediment Professional Judgment Evaluation

Based on the weight of available evidence evaluated by professional judgment, PCOCs will either be included for further evaluation as COCs or excluded as COCs. The professional judgment evaluation takes into account process knowledge, spatial trends, pattern recognition, comparisons to RFETs background and other background data sets, and risk potential for human health and ecological receptors. As discussed in Section 1.2 and Attachment 2, the sample results are adequate for use in the professional judgment because they are of sufficient quality for use in the CRA.

Based on the weight of evidence described in Attachment 3, arsenic and radium-228 in surface soil/surface sediment in the LWNEU are not considered COCs because the weight of evidence supports the conclusion that arsenic and radium-228 concentrations in surface soil/surface sediment in the LWNEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations.

2.2 Contaminant of Concern Selection for Subsurface Soil/Subsurface Sediment

Detected PCOCs in subsurface soil/subsurface sediment samples (Table 1.4) are screened in accordance with the CRA Methodology to identify the COCs.

2.2.1 Subsurface Soil/Subsurface Sediment Cation/Anion and Essential Nutrient Screen

The major cations and anions that do not have toxicity criteria were eliminated from assessments in subsurface soil/subsurface sediment in accordance with the CRA Methodology.

Essential nutrients without toxicity criteria that were detected in subsurface soil/subsurface sediment in the LWNEU are compared to DRIs in Table 2.4. The estimated daily maximum intakes for these PCOCs, based on the nutrients' MDCs and a subsurface soil/subsurface sediment ingestion rate of 100 mg/day, are less than the DRIs. Therefore, these PCOCs were not further evaluated as COCs for subsurface soil/ subsurface sediment.

2.2.2 Subsurface Soil/Subsurface Sediment Preliminary Remediation Goal Screen

The PRG screen for detected analytes in subsurface soil/subsurface sediment is presented in Table 2.5. The MDC and UCL for radium-228 were greater than the PRG. Radium-228 in subsurface soil/subsurface sediment in the LWNEU was retained for further evaluation in the COC selection process.

PRGs were not available for several PCOCs in subsurface soil/subsurface sediment. Analytes without PRGs are listed on Table 2.5 and their effect on the conclusions of the risk assessment results is discussed in the uncertainty section (Section 6.0).

2.2.3 Subsurface Soil/Subsurface Sediment Detection Frequency Screen

A detection frequency screen was not performed for radium-228 in subsurface soil/subsurface sediment because all reported values for radionuclides are considered detects.

2.2.4 Subsurface Soil/Subsurface Sediment Background Analysis

Results of the background statistical comparison for radium-228 is presented in Table 2.3 and discussed in Attachment 3. Box plots for radium-228 (both LWNEU and background) are provided in Attachment 3. Radium-228 was not statistically greater than background at the 0.1 significance level, and, therefore, it is not further evaluated.

2.2.5 Subsurface Soil/Subsurface Sediment Professional Judgment Evaluation

The professional judgment step was not performed for subsurface soil/subsurface sediment because there were no PCOCs retained after the background comparison.

2.3 Contaminant of Concern Selection Summary

A summary of the results of the COC screening process is presented in Table 2.6. No COCs were selected for any of the media at the LWNEU.

3.0 HUMAN HEALTH EXPOSURE ASSESSMENT

The Site Conceptual Model (SCM), presented in Figure 2.1 of the CRA Methodology and discussed in Appendix A, Volume 2 of the RI/FS Report, provides an overview of potential human exposures at RFETS for reasonably anticipated land use. However, all PCOCs were eliminated from further consideration as human health COCs for the LWNEU based on comparisons of MDCs and UCLs to PRGs, background comparisons, or professional judgment (see Section 2.0). A quantitative risk characterization is not necessary for the LWNEU and, therefore, an exposure assessment was not conducted.

4.0 HUMAN HEALTH TOXICITY ASSESSMENT

Procedures and assumptions for the toxicity assessment are presented in the CRA Methodology. All PCOCs were eliminated from further consideration as human health COCs for the LWNEU based on comparisons of MDCs and UCLs to PRGs, background comparisons, or professional judgment (see Section 2.0). A quantitative risk characterization is not necessary for the LWNEU and, therefore, a toxicity assessment was not conducted.

5.0 HUMAN HEALTH RISK CHARACTERIZATION

Information from the exposure assessment and the toxicity criteria sections is integrated in this section to characterize risk to the WRW and WRV receptors. However, all PCOCs were eliminated from further consideration as human health COCs based on comparisons of MDCs and UCLs to PRGs, background comparisons, or professional judgment (see Section 2.0). Therefore, a quantitative risk characterization was not performed for the LWNEU.

6.0 UNCERTAINTIES ASSOCIATED WITH THE HUMAN HEALTH RISK ASSESSMENT

There are various types of uncertainties associated with steps of an HHRA. General uncertainties common to the EUs are discussed in Volume 2, Appendix A of the RI/FS Report. Uncertainties specific to the EU are described below.

6.1 Uncertainties Associated With the Data

Data adequacy for this CRA is evaluated and discussed in Appendix A, Volume 2 of the RI/FS Report. Although there are some uncertainties associated with the sampling and analyses conducted for surface soil/surface sediment and subsurface soil/subsurface sediment at the LWNEU, data are considered adequate for the characterization of risk at the EU. The environmental samples for the LWNEU were collected from 1991 through 2005. The CRA sampling and analysis requirements for the BZ (DOE 2004, 2005a) specify that the minimum sampling density requirement for surface soil/surface sediment is one five-sample composite for every 30-acre grid cell. In surface soil/surface sediment, there are up to 81 samples in the LWNEU.

Another source of uncertainty in the data is the relationship of detection limits to the PRGs for analytes eliminated as COCs because they were not detected or had a low detection frequency (i.e., less than 5 percent). The detection limits were appropriate for the analytical methods used, and this is examined in greater detail in Attachment 1.

6.2 Uncertainties Associated With Screening Values

The COC screening analyses utilized RFETS-specific PRGs based on a WRW scenario. The assumptions used in the development of these values were conservative. For example, it is assumed that a future WRW will consume 100 mg of surface soil/surface sediment for 230 days per year for a period of 18.7 years. In addition, a WRW is assumed to be dermally exposed to and inhale surface soil and surface sediment particles in the air. These assumptions are likely to overestimate actual exposures to surface soil for WRWs in the LWNEU because a WRW will not spend 100 percent of his or her time in this area. Exposure to subsurface soil and subsurface sediment is assumed to occur 20 days per year. The WRW PRGs for subsurface soil/subsurface sediment are also expected to conservatively estimate potential exposures because it is unlikely a WRW will excavate extensively in the LWNEU.

6.2.1 Uncertainties Associated with Potential Contaminants of Concern without Preliminary Remediation Goals

PCOCs for the LWNEU for which PRGs are not available are listed in Table 6.1.

Uncertainties associated with the lack of PRGs for analytes listed in Table 6.1 are considered small. The listed inorganics are not usually included in HHRAs because they are not expected to result in significant human health impacts. Radionuclide PRGs are available for all detected individual radionuclides. Therefore, the lack of PRGs for the gross alpha and gross beta activities is not expected to affect the results of the HHRA.

6.3 Uncertainties Associated with Eliminating Potential Contaminants of Concern Based on Professional Judgment

Arsenic and radium-228 in surface soil/surface sediment were eliminated as COCs based on professional judgment. There is no identified source or pattern of release for arsenic in the LWNEU and the slightly elevated median value of arsenic in the LWNEU is most

likely due to natural variation. The slightly elevated concentrations of radium-228 compared to the PRG in the one surface soil/surface sediment sample analyzed for radium-228 in the LWNEU is also expected to be due to natural variations. The weight of evidence presented in Attachment 3, Section 4.0 supports the conclusion that the concentrations of arsenic and radium-228 are naturally occurring and not due to site activities. Uncertainty associated with the elimination of these chemicals as COCs is low.

No PCOCs were eliminated in subsurface soil/subsurface sediment based on professional judgment in the LWNEU.

6.4 Uncertainties Evaluation Summary

Evaluation of the uncertainties associated with the data and the COC screening processes indicates there is reasonable confidence in the conclusions of the LWNEU risk characterization.

7.0 IDENTIFICATION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN

The ECOPC identification process streamlines the ecological risk characterization for each EU by focusing the assessment on ECOIs that are present in the LWNEU. ECOIs are defined as any chemical detected in the LWNEU and are assessed for surface soils and subsurface soils. ECOIs for sediments and surface water are assessed in Appendix A, Volume 15B of the RI/FS Report. The ECOPC process is described in the CRA Methodology (DOE 2005a) and additional details are provided in Appendix A, Volume 2 of the RI/FS Report. A detailed discussion of the ecological SCM, including the receptors of concern, exposure pathways, and endpoints used in the ERA for the LWNEU, is also provided in Appendix A, Volume 2 of the RI/FS Report.

The SCM presents the pathways of potential exposure from documented historical source areas (IHSSs and PACs) to the receptors of concern. Generally, the most significant exposure pathways for wildlife at the LWNEU are the ingestion of plant, invertebrate, or animal tissue that could have accumulated ECOIs from the source areas through direct uptake or dietary routes, as well as the direct ingestion of potentially contaminated media. For terrestrial plants and invertebrates, the most significant exposure pathway is direct contact with potentially contaminated soils.

The receptors of concern that were selected for assessment are listed in Table 7.1 and include representative birds and mammals in addition to the general plant and terrestrial invertebrate communities. The receptors were selected based on several criteria, including their potential to be found in the various habitats present within RFETS, their potential to come into contact with ECOIs, and the amount of life history and behavioral information available.

The ECOPC identification process consists of two separate evaluations, one for the PMJM receptor and one for non-PMJM receptors. The ECOPC identification process for

the PMJM is conducted separately from non-PMJM receptors because the PMJM is a federally listed threatened species under the Endangered Species Act (63 FR 26517).

7.1 Data Used in the Ecological Risk Assessment

The following LWNEU data are used in the CRA:

- Fifty-seven surface soil samples were collected and analyzed for inorganics (23 samples), organics (12 samples), and radionuclides (57 samples) (Table 1.2).
- Sixteen subsurface soil samples were collected and analyzed for inorganics (14 samples), organics (16 samples), and radionuclides (11 samples) (Table 1.2).

A data summary is provided in Table 1.5 for surface soil and Table 1.7 for subsurface soil.

Sediment and surface water data for the LWNEU were also collected (Section 1.1.5) and are evaluated for the ERA in Appendix A, Volume 15B of the RI/FS Report. As discussed in Section 8.0, surface water EPCs are used in the risk model to estimate exposure via the surface water ingestion pathway. A total of 933 distinct surface water samples were collected in the LWNEU and analyzed for inorganics (873 samples), organics (17 samples), and radionuclides (933 samples).

As described in Section 1.1.4, there are 18 sample locations occurring in PMJM habitat within the LWNEU. Surface soil samples were collected and analyzed for inorganics (nine out of 18 samples), organics (eight out of 18 samples) and radionuclides (12 out of 18 samples). A data summary is provided in Table 1.6 for surface soil in PMJM habitat. Sampling locations and PMJM habitat patches within the LWNEU are shown on Figure 1.5.

7.2 Identification of Surface Soil Ecological Contaminants of Potential Concern

ECOPCs for surface soil were identified for non-PMJM and PMJM receptors in accordance with the sequence presented in the CRA Methodology.

7.2.1 Comparison with No Observed Adverse Effect Level (NOAEL) Ecological Screening Levels

In the first step of the ECOPC identification process, the MDCs of ECOIs in surface soil were compared to receptor-specific NOAEL ESLs. NOAEL ESLs for surface soil were developed in the CRA Methodology for three receptor groups: terrestrial vertebrates, terrestrial invertebrates, and terrestrial plants.

Non-PMJM Receptors

The NOAEL ESLs for non-PMJM receptors are compared to MDCs in surface soil in Table 7.1. The results of the NOAEL ESL screening analyses for all receptor types are

summarized in Table 7.2. Analytes with a "Yes" in any of the "Exceedance" columns in Table 7.2 are evaluated further.

NOAEL ESLs were not available for several ECOI/receptor pairs (Tables 7.1 and 7.2). These ECOI/receptor pairs are discussed as ECOIs with uncertain toxicity in Section 10.0, along with the potential impacts to the risk assessment.

PMJM Receptors

The NOAEL ESLs for PMJM receptors were compared to the MDCs of ECOIs in surface soil collected from PMJM habitat (Table 7.3). The MDCs in surface soil that exceed the NOAEL ESLs are identified in Table 7.3 with a "Yes" in the column heading "EPC > PMJM ESL?"

Analytes for which a PMJM NOAEL ESL is not available are identified with a "UT" in Table 7.3 under the column heading "EPC > PMJM ESL?" These analytes are discussed in the uncertainty section (Section 10.0) as ECOIs with uncertain toxicity.

7.2.2 Surface Soil Frequency of Detection Evaluation

The ECOPC identification process for non-PMJM receptors involves an evaluation of detection frequency for each ECOI retained after the NOAEL screening step. If the detection frequency is less than 5 percent, then population-level risks are considered highly unlikely and the ECOI is not further evaluated. None of the chemicals detected in surface soil at the LWNEU that were retained after the NOAEL ESL screening step had a detection frequency less than 5 percent (Table 1.5). Therefore, no ECOIs were excluded based on the detection frequency evaluation for surface soil in the LWNEU.

7.2.3 Surface Soil Background Comparisons

The ECOIs retained after the NOAEL ESL screening and the detection frequency evaluation were then compared to site-specific background concentrations where available. The background comparisons are presented in Tables 7.4 and 7.5 and discussed in Attachment 3. The statistical methods used for the background comparison are summarized in Appendix A, Volume 2 of the RI/FS Report.

Non-PMJM Receptors

The results of the background comparisons for the non-PMJM receptors are presented in Table 7.4. The analytes listed as being retained as ECOIs in Table 7.4 are evaluated further using upper-bound EPCs in the following section.

PMJM Receptors

The background comparison for PMJM receptors is performed using the same methods as for non-PMJM receptors, but the EU data set is restricted to soil samples from within PMJM habitat. Table 7.5 presents the results of the PMJM comparison to background.

Attachment 3 presents further discussion of the PMJM background analysis. ECOIs listed as "Yes" on Table 7.5 are further evaluated in the professional judgment evaluation.

7.2.4 Exposure Point Concentration Comparisons to Threshold ESLs (tESLs)

The ECOIs retained after completion of all previous evaluations for non-PMJM receptors are then compared to threshold ecological screening levels (tESLs) using EPCs specific to small and large home-range receptors. The calculation of EPCs is described in Attachment 3 and Appendix A, Volume 2 of the RI/FS Report.

Statistical concentrations for each ECOI retained for the tESL screen are presented in Table 7.6. The EPC for small home-range receptors is the 95 percent UCL of the 90th percentile (upper tolerance limit [UTL]), or the MDC in the event that the UTL is greater than the MDC. The EPC for large home-range receptors is the UCL of the mean, or the MDC in the event that the UCL is greater than the MDC.

Small home-range receptors include terrestrial plants, terrestrial invertebrates, mourning dove, American kestrel, deer mouse, and black-tailed prairie dog. These receptors are evaluated by comparing the small home-range EPC (UTL) for each ECOI to the limiting (or lowest) small home-range receptor tESL (if available). In the event that tESLs are not available, the limiting NOAEL ESL is used in accordance with the CRA Methodology.

Large home-range receptors, such as coyote and mule deer, are evaluated by comparing the large home-range EPC (UCL) for each ECOI to the limiting large home-range receptor tESL (if available). In the event that tESLs are not available, the limiting NOAEL ESL is used in accordance with the CRA Methodology.

The upper-bound EPC comparison to limiting tESLs for small and large home-range receptors is presented in Table 7.7. Analytes that exceed the limiting tESLs are further evaluated by comparing them to the receptor-specific tESLs (if available) to identify receptors of potential concern. Analytes exceeding the limiting tESLs for small home-range receptors are compared to receptor-specific tESLs in Table 7.8, and analytes exceeding limiting tESLs for large home-range receptors are compared to receptor-specific tESLs in Table 7.9.

Chemicals that exceed any tESLs (if available) are assessed in the professional judgment evaluation. Any analyte/receptor pairs that are retained through professional judgment are identified as ECOPCs and are carried forward in the risk assessment.

7.2.5 Surface Soil Professional Judgment Evaluation

Non-PMJM Receptors

Based on the weight-of-evidence, professional judgment described in Attachment 3, aluminum, antimony, boron, chromium, lithium, molybdenum, nickel, selenium, tin, vanadium, and zinc in surface soil at the LWNEU were not considered ECOPCs for non-PMJM receptors and are not further evaluated quantitatively.

4,4'-DDT was identified as an ECOPC and retained for further evaluation in the risk characterization.

PMJM Receptors

Based on the weight-of-evidence, professional judgment described in Attachment 3, chromium and nickel in surface soil were not considered ECOPCs for PMJM receptors and are not further evaluated quantitatively.

7.2.6 Summary of Surface Soil Ecological Contaminants of Potential Concern

The ECOPC screening process for surface soil is summarized below for non-PMJM receptors and PMJM receptors.

Non-PMJM Receptors

Most inorganic, organic, and radionuclide surface soil ECOIs for non-PMJM receptors in the LWNEU were eliminated from further consideration in the ECOPC identification process based on one of the following: 1) the MDC of the ECOI was less than the lowest ESL; 2) no ESLs were available (these ECOIs are discussed in Section 10.0); 3) the concentration of the ECOI in LWNEU surface soils was not statistically greater than background surface soils; 4) the upper-bound EPC did not exceed the limiting tESL; or 5) the weight-of-evidence, professional judgment evaluation indicated that the ECOI was not a site-related contaminant of potential concern. Chemicals that were retained are identified as ECOPCs and are presented in Table 7.10.

A summary of the ECOPC screening process for non-PMJM receptors is presented in Table 7.10. Receptors of potential concern for each ECOPC are also presented. The ECOPC/receptor pairs are evaluated further in Section 8.0 (Ecological Exposure Assessment), Section 9.0 (Ecological Toxicity Assessment), and Section 10.0 (Ecological Risk Characterization).

PMJM Receptors

ECOIs in surface soil in PMJM habitat located within the LWNEU were evaluated in the ECOPC identification process. ECOIs were removed from further evaluation in the ECOPC identification process based on one of the following: 1) the MDC of the ECOI was less than the NOAEL ESL for PMJM; 2) no NOAEL ESLs were available (these ECOIs are discussed in Section 10.0); 3) the ECOI concentrations within the PMJM habitat in LWNEU were not statistically greater than those from background surface soils; or 4) the weight-of-evidence, professional judgment evaluation indicated that the ECOI was not a site-related contaminant of potential concern. No ECOIs were retained as surface soil ECOPCs for PMJM receptors in the LWNEU.

The results of the ECOPC identification process for the PMJM are summarized in Table 7.11.

7.3 Identification of Subsurface Soil Ecological Contaminants of Potential Concern

Subsurface soil sample locations for soil collected at a starting depth of 0.5 to 8 feet bgs in the LWNEU are identified on Figure 1.7. A data summary for subsurface soil less than 8 feet deep is presented in Table 1.7.

7.3.1 Comparison to No Observed Adverse Effect Level (NOAEL) Ecological Screening Levels

The CRA Methodology indicates subsurface soil is evaluated for those ECOIs that have greater concentrations in subsurface soil than in surface soil. In order to conduct the most conservative CRA, subsurface soil is evaluated for all EUs regardless of the presence/ absence of a change in concentrations from surface soil and subsurface soil. The MDCs of ECOIs in subsurface soil were compared to NOAEL ESLs for burrowing receptors (Table 7.12). ECOIs with MDCs greater than the NOAEL ESL for the prairie dog are further evaluated in the ECOPC identification process.

NOAEL ESLs are not available for some analytes, and these are identified as "N/A" in Table 7.12. These constituents are considered ECOIs with UT and are discussed in the uncertainty analysis (Section 10.0).

7.3.2 Subsurface Soil Detection Frequency Evaluation

The ECOPC identification process for burrowing receptors includes an evaluation of detection frequency for each ECOI retained after the NOAEL ESL screening step. If the detection frequency is less than 5 percent, population-level risks are considered highly unlikely and the ECOI is not further evaluated. The detection frequencies for chemicals in subsurface soil are presented in Table 1.7. None of the chemicals in subsurface soil at the LWNEU that were retained after the NOAEL ESL screening step had a detection frequency of less than 5 percent. Therefore, no ECOIs were eliminated from further evaluation based on low detection frequencies for subsurface soil in the LWNEU.

7.3.3 Subsurface Soil Background Comparison

The ECOIs retained after the ESL screening and detection frequency evaluation were compared to site-specific background concentrations where available. The background comparisons are presented in Table 7.13 and discussed in Attachment 3. The statistical methods used in the background comparison are summarized in Attachment 3.

Analyses were conducted to assess whether arsenic in LWNEU subsurface soil is statistically greater than that in sitewide background surface soil at the 0.1 level of significance. The results of the statistical comparisons of the LWNEU data to background data indicate that site concentrations of arsenic in LWNEU subsurface soil are statistically greater than background concentrations. Arsenic is evaluated further using upper-bound EPCs in the following section.

7.3.4 Exposure Point Concentration Comparisons to Threshold ESLs

ECOIs retained after all previous evaluations for burrowing receptors are compared to tESLs using EPCs specific to small home-range receptors. The calculation of upper-bound EPCs is discussed in the CRA Methodology (DOE 2005a).

Because only arsenic was retained following the background analysis step, statistical concentrations for arsenic are presented in Table 7.14. The EPC comparison to tESLs for burrowing receptors is presented in Table 7.15. The subsurface soil UTL for arsenic is lower than the tESL for the prairie dog receptor; therefore, arsenic was not evaluated further in professional judgment.

7.3.5 Subsurface Soil Professional Judgment

ECOIs with subsurface soil concentrations that exceed NOAEL ESLs, which have been detected in more than 5 percent of samples, that have concentrations statistically higher than background data, and which exceed tESLs are subject to a professional judgment evaluation. However, no ECOIs had subsurface soil concentrations that exceeded tESLs; therefore, no weight-of-evidence professional judgment evaluation was needed for subsurface soil in the LWNEU.

7.3.6 Summary of Subsurface Soil Ecological Contaminants of Potential Concern

All subsurface soil ECOIs for burrowing receptors in the LWNEU were eliminated from further consideration in the ECOPC identification process based on one of the following: 1) the MDC of the ECOI was less than NOAEL ESL for the burrowing receptor; 2) no ESLs were available (these ECOIs are discussed in Section 10.0); 3) the concentration of the ECOI in LWNEU subsurface soils was not statistically greater than background subsurface soils; or 4) the upper-bound EPC was less than the tESL. The results of the subsurface soil ECOPC identification process for burrowing receptors are summarized in Table 7.16.

7.4 Summary of Ecological Contaminants of Potential Concern

ECOIs in surface and subsurface soil in the LWNEU were evaluated in the ECOPC identification process for non-PMJM receptors, PMJM receptors, and burrowing receptors. 4,4'-DDT was identified as an ECOPC for selected non-PMJM receptors (Table 7.10). No chemicals were identified as ECOPCs for the PMJM (Table 7.11). No chemicals were identified as ECOPCs for burrowing receptors (Table 7.16). No other ECOIs were retained past the professional judgment step of the ECOPC identification process for any other receptor group (non-PMJM receptors, PMJM receptors, or burrowing receptors).

8.0 ECOLOGICAL EXPOSURE ASSESSMENT

The ECOPC identification process defined the steps necessary to identify those chemicals that could not reliably be removed from further consideration in the ERA process. The

list of ECOPC/receptor pairs of potential concern (Table 8.1) represents those media, chemicals, and receptors in the LWNEU that require further assessment. The characterization of risk defines a range of potential exposures to site receptors from the ECOPCs and a parallel evaluation of the potential toxicity of each of the ECOPCs as well as the uncertainties associated with the risk characterization. This section provides the estimation of potential exposure to surface soil ECOPCs for the receptors identified in Section 7.0 and Table 8.1. Exposure to ECOPCs via the ingestion of surface water is also considered a potentially significant exposure route as presented in the CRA Methodology (DOE 2005a). Details of the two exposure models, concentration-based exposure and dosage-based exposure, are presented in Appendix A, Volume 2 of the RI/FS Report.

8.1 Exposure Point Concentrations

Surface soil EPCs for all non-PMJM receptors were calculated using both Tier 1 and Tier 2 methods as described in the CRA Methodology (DOE 2005a). Tier1 EPCs are based on the upper confidence limits of the arithmetic mean concentration for the EU data set, and Tier 2 EPCs are calculated using a spatially-weighted averaging approach. The 30-acre grid used for the Tier 2 calculations is shown on Figure 8.1. The Tier 1 and Tier 2 UTLs and UCLs are presented in Table 8.2. The methodology for the calculation of Tier 2 statistics is provided in Appendix A, Attachment 2 of the RI/FS Report.

The surface water EPCs were calculated for ECOIs that were identified as soil ECOPCs using the same statistical basis as determined for the soil ECOPCs. For example, if the soil EPC statistic was the UCL, then the UCL concentration in surface water (total values only) was calculated as described for soils and selected as the EPC. Surface water EPCs for all ECOPCs are presented in Table 8.3. All surface water data are provided on the CD in Attachment 6.

8.2 Receptor-Specific Exposure Parameters

Receptor-specific exposure factors are needed to estimate exposure to ECOPCs for each representative species. These include body weight; food, water, and media ingestion rates; and diet composition and respective proportion of each dietary component. Daily rates for intake of forage, prey, water, and incidental ingestion of soils were developed in the CRA Methodology (DOE 2005a) and are presented in Table 8.4 for the receptors of potential concern carried forward in the ERA for the LWNEU.

8.3 Bioaccumulation Factors

The measurement or estimation of concentrations of ECOPCs in wildlife food is necessary to evaluate how much of a receptor's exposure is via food versus direct uptake of contaminated media. Conservative bioaccumulation factors (BAFs) were identified in the CRA Methodology (DOE 2005a). These BAFs are either simple ratios between chemical concentrations in biota and soil or are based on quantitative relationships such as linear, logarithmic, or exponential equations. The values reported in the CRA Methodology are used as the BAFs for purposes of risk estimation.

8.4 Intake and Exposure Estimates

Intake and exposure estimates were completed for each ECOPC/receptor pair identified in Table 8.1. The estimates use the default exposure parameters and BAFs presented in Appendix B of the CRA Methodology (DOE 2005a) and described in the previous subsection. These intake calculations represent conservative estimates of food tissue concentrations calculated from the range of upper-bound EPCs including the Tier 1 and Tier 2 UTLs and UCLs.

Non-PMJM Receptors

The intake and exposure estimates for ECOPC/non-PMJM receptor pairs are presented in Attachment 4. A summary of the exposure estimates for 4,4'-DDT (American kestrel and the insectivorous mourning dove) is presented in Table 8.5.

9.0 ECOLOGICAL TOXICITY ASSESSMENT

Exposure to wildlife receptors was estimated for representative species of functional groups based on taxonomy and feeding behavior in Section 8.0 in the form of a daily rate of intake for each ECOPC/receptor pair. To estimate risk, soil concentrations (plants and invertebrate exposure) and calculated intakes (birds and mammals) must then be compared to the toxicological properties of each ECOPC. The laboratory-based toxicity benchmarks are termed toxicity reference values (TRVs) and are of several basic types. The NOAEL and no observed effect concentration (NOEC) TRVs are intake rates or soil concentrations below which no ecologically significant effects are expected. The NOAEL and NOEC TRVs were used to calculate the NOAEL ESLs employed in screening steps of the ECOPC identification process to eliminate chemicals that have no potential to cause risk to the representative receptors. The lowest observed adverse effects level (LOAEL) TRV is a concentration above which the potential for some ecologically significant adverse effect could be elevated. The threshold TRVs represent the hypothetical dose at which the response for a group of exposed organisms may first begin to be significantly greater than the response for unexposed receptors and is calculated as the geometric mean of the NOAEL and LOAEL. Threshold TRVs were calculated based on specific data quality rules for use in the ECOPC identification process for a small subset of ECOIs in the CRA Methodology (DOE 2005a).

TRVs for ECOPCs identified for the LWNEU were obtained from the CRA Methodology. The pertinent TRVs for the LWNEU are presented for birds in Table 9.1.

10.0 ECOLOGICAL RISK CHARACTERIZATION

Risk characterization includes risk estimation and risk description. Details of these components are described in the CRA Methodology and Appendix A, Volume 2 of the RI/FS Report. Predicted risks should be viewed in terms of the potential for the assumptions used in the risk characterization to occur in nature, the uncertainties

associated with the assumptions, and in the potential for effects on the population of receptors that could inhabit the LWNEU.

Potential risks to terrestrial plants, invertebrates, birds, and mammals are evaluated using a hazard quotient (HQ) approach. A HQ is the ratio of the estimated exposure of a receptor to a TRV that is associated with a known level of toxicity, either a no effect level (NOAEL or NOEC) or an effect level (LOAEL or lowest effects concentration [LOEC]):

$$HQ = Exposure / TRV$$

As described in Section 8.0, the units used for exposure and TRV depend upon the type of receptor evaluated. For plants and invertebrates, exposures and TRVs are expressed as concentrations (mg/kg soil). For birds and mammals, exposures and TRVs are expressed as ingested doses (mg/kg BW/day).

In general, if the NOAEL-based HQ is less than 1, then no adverse effects are predicted. If the LOAEL-based HQ is less than 1 but the NOAEL-based HQ is above 1, then some adverse effects are possible, although it is expected that the magnitude and frequency of the effects will usually be low (assuming the magnitude and severity of the response at the LOAEL are not large and the endpoint of the LOAEL accurately reflects the assessment endpoints for that receptor). If the LOAEL-based HQ is greater than or equal to 1, the risk of an adverse effect is of potential concern, with the probability and/or severity of effect tending to increase as the value of the HQ increases.

When interpreting HQ results for non-PMJM ecological receptors, it is important to remember that the assessment endpoint to non-PMJM receptors is based on the sustainability of exposed populations, and risks to some individuals in a population may be acceptable if the population is expected to remain healthy and stable. For threatened and endangered species, such as the PMJM, the interpretation of HQ results is based on potential risks to individuals rather than populations.

HQs were calculated for each ECOPC/receptor pair based on the exposures estimated and TRVs presented in the preceding sections. The NOAEL and NOEC TRVs along with default screening-level exposure assumptions are first used to calculate HQs. However, these no effects HQs are typically considered as screening level results and do not necessarily represent realistic risks for the site. EPA risk assessment guidance (EPA 1997) recommends a tiered approach to evaluation, and following the first tier of evaluation "the risk assessor should review the assumptions used (e.g., 100 percent bioavailability) against values reported in the literature (e.g., only up to 60 percent for a particular contaminant), and consider how the HQs would change if more realistic conservative assumptions were used instead." Accordingly, LOAEL and threshold TRVs are also used in this evaluation to calculate HQs. Where LOAEL HQs greater than 1 are calculated using default exposure assumptions, and the uncertainty analysis indicates that alternative BAFs and/or TRVs would be beneficial to reduce uncertainty and conservatism, alternative HQs are calculated.

10.1 Chemical Risk Characterization

Chemical risk characterization utilizes quantitative methods to evaluate potential risks to ecological receptors. In this risk assessment, the quantitative method used to characterize chemical risk is the HQ approach. As noted above, HQs are usually interpreted as follows:

HQ Values		**Interpretation of HQ Results**
NOAEL-based	**LOAEL-based**	
≤ 1	≤ 1	Minimal or no risk
> 1	≤ 1	Low-level risk[a]
> 1	> 1	Potential adverse effects

[a]Assuming magnitude and severity of response at LOAEL are relatively small and based on endpoints appropriate for the assessment endpoint of the receptor considered.

One potential limitation of the HQ approach is that calculated HQ values may sometimes be uncertain due to simplifications and assumptions in the underlying exposure and toxicity data used to derive the HQs. Where possible, this risk assessment provides information on three potential sources of uncertainty, described below.

- **EPCs.** Because surface soil sampling programs in the EU sometimes tended to focus on areas of potential contamination (IHSS/PAC/UBCs), EPCs calculated using the Tier 1 approach (which assumes that all samples are randomly spread across the EU and are weighted equally) may tend to yield an EPC that is biased high. For this reason, a Tier 2 area-weighting approach was used to derive additional EPCs that help compensate for this potential bias. HQs were always calculated based on both Tier 1 and Tier 2 EPCs for non-PMJM receptors. No Tier 2 EPCs were calculated for PMJM receptors due to the limited size of their habitat.

- **BAFs.** For wildlife receptors, concentrations of contaminants in dietary items were estimated from surface soil using uptake equations. When the uptake equation was based on a simple linear model (e.g., $C_{tissue} = BAF * C_{soil}$), the default exposure scenario used a high-end estimate of the BAF (the 90th percentile BAF). However, the use of high-end BAFs may tend to overestimate tissue concentrations in some dietary items. In order to estimate more typical tissue concentrations, where necessary, an alternate exposure scenario calculated total chemical intake using a 50th percentile (median) BAF and HQs were calculated. The use of the median BAF is consistent with the approach used in the ecological soil screening level (EcoSSL) guidance (EPA 2003, 2005).

- **TRVs.** The CRA Methodology utilized an established hierarchy to identify the most appropriate default TRVs for use in the ECOPC selection process. However, in some instances, the default TRV selected may be overly conservative with regard to characterizing population-level risks. The determination of whether the default TRVs are thought to yield overly conservative estimates of risk is addressed on a chemical-by-chemical basis in the following subsections. When an alternate TRV is identified, the chemical-specific subsections provide a discussion of why the alternate TRV is thought to be appropriate to provide an alternative estimate of toxicity (e.g., endpoint relevance, species relevance, data quality, chemical form, etc.), and HQs were calculated using both default and alternative TRVs where necessary.

The influences of each of these uncertainties on the calculated HQs were evaluated both alone and in concert in the risk description for each chemical. Uncertainties related to the BAFs, TRVs and background risk are presented for each chemical in Attachment 5. Where uncertainties were deemed to be high, Attachment 5 provides alternative BAFs and/or TRVs that are then incorporated into the risk characterization as appropriate.

HQs calculated using the default BAFs and HQs with the Tier 1 and Tier 2 EPCs are provided in Table 10.1 for each ECOPC/Receptor pair. Shaded cells represent default HQ calculations based on exposure and toxicity models specifically identified in the CRA Methodology. Where no LOAEL HQs exceed 1 using the default exposure and toxicity values, no further HQs were calculated. Since the default HQs are generally the most conservative risk estimations, if low risk is estimated using these values then further reductions of conservatism would only serve to reduce risk estimates further.

Where LOAEL HQs greater than 1 are calculated using default assumptions, and the uncertainty analysis indicates that median BAFs and/or additional TRVs would be beneficial to reduce uncertainty and conservatism, alternative HQs are calculated and presented in Table 10.1 as appropriate.

The selection of which EPC (e.g., UTL or UCL) is of primary importance will depend upon the type of receptor and the relative home range size. Only the UTL EPC is provided for small home range receptors and only the UCL is provided for large home range receptors. Only the small home range receptors are of concern in the LWNEU (see Table 10.1).

All calculated exposure estimates and HQ values are also provided in Attachment 4. These include the default and refined HQs if needed. The results for each ECOPC are discussed in more detail below.

The risk description incorporates results of the risk estimates along with the uncertainties associated with the risk estimations and other lines of evidence to evaluate potential chemical effects on ecological receptors in the LWNEU following accelerated actions at RFETS. Information considered in the risk description includes receptor groups potentially affected, type of TRV exceeded (e.g., NOAEL versus LOAEL), relation of EU concentrations to other criteria such as EPA Eco-SSLs, and risk above background

conditions. In addition, other site-specific and regional factors are considered such as the use of a given ECOPC within the EU related to historical RFETS activities, comparison of ECOPC concentrations within the LWNEU to the rest of the RFETS site as it relates to background, and/or comparison to regional background concentrations.

10.1.1 4,4-DDT

4,4'-DDT HQs for the American kestrel and mourning dove (insectivore) are presented in Table 10.1. 4,4'-DDT was not identified as an ECOPC in the LWNEU for any other receptors. Figure 10.1 shows the spatial distribution of 4,4'-DDT in relation to the lowest ESL, and also presents the data used in the calculation of the Tier 2 EPCs.

For the American kestrel and mourning dove (insectivore), LOAEL HQs were less than 1 using the default exposure assumptions and no additional HQs were calculated.

Care should, however, be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors, regardless of whether refined HQs were calculated to address uncertainties in the default risk model.

4,4'-DDT Risk Description

4,4'-DDT was identified as an ECOPC for the American kestrel and mourning dove (insectivore) receptors only. Information on the historical use and a summary of site data and background data is provided in Attachment 3.

Non-PMJM Receptors – Small Home Range

NOAEL HQs using default risk models were greater than 1 for the American kestrel and the mourning dove (insectivore) (Table 10.1). LOAEL HQs were less than 1 for the American kestrel and mourning dove (insectivore). Therefore, risks to populations of American kestrel and mourning dove (insectivore) from 4,4'-DDT in surface soils are likely to be low.

4,4'-DDT was detected in only one of four samples, located near the RFETS site boundary, just west of Indiana Street. The other three nondetect sample results for 4,4'-DDT are located upgradient and west of the one detection. The one detection was only slightly above the reporting limit (26 µg/kg versus a reporting limit of 16 µg/kg) and the other three samples were also slightly above the reporting limit (20, 21, and 22 µg/kg) but were not reported as detections. Comparing these reporting limits to a LOAEL-based soil concentration (200 µg/kg), indicates there is little potential for adverse ecological effects if 4,4'-DDT was detected at the reporting limits.[1] 4,4'-DDT in surface soil has a mean concentration of 14.4 µg/kg and a standard deviation of 7.8 µg/kg. In the adjacent Wind Blown Area EU, there are 40 sample results for 4,4'-DDT and none showed a

[1] The LOAEL-based soil concentration is estimated by multiplying the mourning dove (insectivore) ESL (it is lower than the ESL for the American kestrel) by the LOAEL/NOAEL ratio for birds (see Appendix B, Table B-2 of the CRA Methodology for the Lowest Bounded LOAELs and Final NOAELs for birds). A reporting limit/LOAEL-based soil concentration ratio greater than one indicates a potential for an adverse ecological effect if 4,4'-DDT was detected at the reporting limit.

detection. In addition, there are no detections of 4,4'-DDT in stream sediments in North Walnut Creek, South Walnut Creek, or McKay Ditch (DOE 1996).

Table 10.2 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL and LOAEL TRVs were used in the HQ calculations. The summary is based on the single grid cell mean where 4,4'-DDT was detected (Figure 10.1).All other grid cell means were based on nondetected results and were not included in the HQ summary. The NOAEL HQ was greater than 1 for the grid mean, but the LOAEL HQ was less than 1 for the most sensitive receptor (mourning dove [insectivore]). The results of the grid-cell analysis indicate that the average exposure to sub-populations of mourning dove (insectivore) results in low risk from exposure to 4,4'-DDT.

10.2 Ecosystem Characterization

An ecological monitoring program has been underway since 1991 when baseline data on wildlife species was gathered (Ebasco 1992). The purpose of this long-term program was to monitor specific habitats to provide a sitewide database from which to monitor trends in the wildlife populations at RFETS. Although a comprehensive compilation of monitoring results has not been presented, the annual reports of the monitoring program provide localized information and insights on the general health of the RFETS ecosystem. Permanent transects through three basic habitats were run monthly for more than a decade (K-H 2002a). Observations were recorded concerning the abundance, distribution, and diversity of wide-ranging wildlife species, including observations of migratory birds, raptors, coyotes, and deer. Small mammal monitoring occurred through several tasks in the monitoring program. The Ecological Monitoring Program (DOE 1995) established permanent transects for small mammal monitoring in three habitat types: xeric grasslands, mesic grasslands, and riparian habitats. PMJM studies established small mammal trapping in nearly all riparian habitats across the site (K-H 1998a, 1999a, 1999b, 2000a, 2000b, 2001, 2002a).

Migratory birds were tracked during all seasons, but most notably during the breeding season. Over 8 years of bird survey data were collected on 18 permanent transects. Field observations were summarized into species richness and densities by habitat type. Habitats comprised the general categories of grasslands, woodlands and wetlands. However, summaries in annual reports are grouped by habitat types across RFETS and not within EUs because EU boundaries were determined well after the monitoring program had begun. Additionally, wide-ranging animals may use habitat in several EUs and do not recognize EU boundaries.

Summarizing songbird surveys over the breeding season, diversity indices for RFETS for all habitats combined over 8 years of observations (1991, 1993-1999) show a steady state in diversity of bird communities (K-H 2000a). Among habitats, results were similar with the exception of an increasing trend in species richness and a decreasing trend in bird densities in woodland habitats. Woodland bird communities consistently show the highest diversity when compared with bird communities in wetlands and grasslands. The

decreasing trend can be mostly attributed to transient species (i.e., those species not usually associated with woody cover) except for red-tail hawk (*Buteo jamaicensis*) and American goldfinch (*Carduelis tristis*). The red-tailed hawk change in density can be attributed to a loss of nesting sites in Upper Woman Creek during the survey period. Goldfinch abundance can be heavily influenced by the availability of food sources.

A subgroup of migratory birds is the neotropical migrants, which show declining populations in North America (Audubon 2005; Nature Conservancy 2005). Most of this decline is thought to be due to conversion of forest land to agriculture in the tropics, and conversion to real estate development in North America. Grassland birds that are neotropical migrants are also in decline. However, over the last 5 years at RFETS, the declining trends have not been observed and densities for this group show an increase.

Raptors, big game species, and carnivores were observed through relative abundance surveys and multi-species surveys (16 permanent transects) that provide species-specific sitewide counts. Raptors were noted on relative abundance surveys and nest sites were visited repeatedly during the nesting season to confirm nesting success. The three most common raptors at RFETS are red-tailed hawk, great horned owl (*Bubo virginianus*), and American kestrel (*Falco sparverius*) (K-H 2002a). One Swainson's hawk nest was noted in North Walnut Creek near the A-1 Pond, and one great horned owl nest was observed within South Walnut Creek. All nests typically fledged two young of each species, except kestrels, which usually fledged two to three young. Each species had a successful nesting season each year during the monitoring period from 1991 to 1999, with a single exception. This exception was the loss of the red-tail hawk nest in Upper Woman Creek (K-H 1997a and 1998a) due to weather. The continued presence of nesting raptors at RFETS (K-H 2002b) indicates that habitat quality and protection from human disturbance have contributed to making RFETS a desirable location for raptors to reproduce. Adequate habitat provides essential seasonal requirements. RFETS is estimated to be at optimum population density for raptors given available habitat and territorial nature of these species (K-H 2000a).

Two deer species inhabit RFETS: mule deer (*Odocoileus hemionus*) and white-tailed deer (*Odocoileus virginianus*). No white-tailed deer were present at RFETS in 1991 when monitoring began (K-H 2002a). In 2000 (K-H 2001) numbers of white-tailed deer were estimated to be between 10 and 15 individuals. White-tailed deer frequent LWNEU, but spend the majority of their time in LWOEU. Mule deer frequent all parts of RFETS (14 mi^2) year-round. The RFETS population from winter counts is estimated at a mean 125 individuals (n = 7), with a density of 14 deer per square mile (K-H 2000a, 2002a). Winter mule deer counts have varied from 100 to 160 individuals over the monitoring period (1994 to 2000) with expected age/sex class distributions (K-H 2001). The mule deer populations from RFETS have been increasing at a steady state, with good age/sex distributions (K-H 2001) over time and similar densities when compared to other "open" populations that are not hunted. This provides a good indicator that habitat quality is high and that site activities have not affected deer populations. It is unlikely that deer populations are depressed or reproduction is affected by contaminants. A recent study on actinides in deer tissue found that plutonium levels were near or below detection limits

(Todd and Sattelberg 2004). This provides further support that the deer population is healthy.

Coyotes (*Canis latrans*) are the top mammalian predator at RFETS. They prey upon mule deer fawns and other smaller prey species. The number of coyotes using the site has been estimated at 14 to 16 individuals (K-H 2002a). Through surveys across the site, coyotes have been noted to have reproduction success with as many as six dens active in 1 year. Typically, at RFETS, three to six coyote dens support an estimated 14 to 16 individuals at any given time (K-H 2001). No coyote dens have ever been found within the LWNEU, likely due to the large amount of human activities associated with pond management. Coyotes have exhibited a steady population over time, thereby indicating their prey species continue to be abundant and healthy.

The LWNEU has been trapped over several years (DOE 1995; K-H 1998a, 2001) under the Ecological Monitoring Program. Initially (DOE 1995), two monitoring sites, a mesic grassland and a riparian site, were established for long-term monitoring. Results from this trapping effort revealed typical small mammal communities with normal densities of each species (DOE 1995; Fitzgerald et al. 1994). PMJM have been captured in the LWNEU over the last decade (DOE 1995; K-H 1998a, 1998b, 2000a, 2000b) and have persisted at expected densities over time. Common species found in riparian areas have also been captured with PMJM, indicating a typical community of small mammals in the LWNEU. Results of small mammal trapping from 1993 to 2000 give indications of diverse and healthy small mammal communities in the LWNEU, and monitoring has revealed abundance and species diversity that would be expected in typical native ecosystems on the plains of Colorado (Fitzgerald et al. 1994).

The high species diversity and continued use of the site by numerous vertebrate species verify that habitat quality for these species remains acceptable and the ecosystem functions are being maintained (K-H 2000a). Data collected on wildlife abundance and diversity indicate that wildlife populations are stable and species richness remains high during remediation activities at RFETS, including wildlife using the LWNEU.

10.3 General Uncertainty Analysis

Quantitative evaluation of ecological risks is limited by uncertainties regarding the assumptions used to predict risk and the data available for quantifying risk. These limitations are usually addressed by making estimates based on the data available or by making assumptions based on professional judgment when data are limited. Because of these assumptions and estimates, the results of the risk calculations themselves are uncertain, and it is important for risk managers and the public to view the results of the risk assessment with this in mind. Chemical-specific uncertainties are presented in Attachment 5 of this document and were discussed in terms of their potential effects on the risk characterization in the risk description section for each ECOPC. The following general uncertainties associated with the ERAs for all the EUs may under- or overestimate risk to an unknown degree; a full discussion of these general uncertainties is provided in Volume 2 of Appendix A of the RI/FS Report:

- Uncertainties associated with data quality and adequacy;
- Uncertainties associated with the ECOPC identification process;
- Uncertainties associated with the selection of representative receptors;
- Uncertainties associated with exposure calculations;
- Uncertainties associated with the development of NOAEL ESLs;
- Uncertainties associated with the lack of toxicity data for ECOIs; and
- Uncertainties associated with eliminating ECOIs based on professional judgment.

The following sections are potential sources of general uncertainty that are specific to the LWNEU ERA.

10.3.1 Uncertainties Associated With Data Adequacy and Quality

Sections 1.2 and 1.3 summarize the general data adequacy and data quality for the LWNEU, respectively. A more detailed discussion is presented in Appendix A, Volume 2, Attachments 2 and 3 of the RI/FS Report, and Attachment 2 of this volume. The data quality assessment indicates the data are of sufficient quality for use in the CRA. The adequacy of the LWNEU data was assessed by comparing the number of samples for each analyte group in each medium as well as the spatial and temporal distributions of the data to data adequacy guidelines. Except for PCBs, the assessment indicates the data meet the data adequacy guidelines. There is limited data for PCBs in surface soil and surface water, and no PCB data for surface soil in the PMJM habitat patches. However, the Flume Pond is not expected to be a source of PCB contamination for the LWNEU, and PCBs are not present in surface soil, sediment or surface water of Walnut Creek within the LWNEU. Therefore, although the existing PCB data do not meet the minimal data adequacy guidelines for the EU, these lines of evidence indicate PCBs are not likely to be present in surface soil for this EU. Data used in the CRA must have detection limits to allow meaningful comparison to ESLs. When these detection limits exceed the respective ESLs, this is a source of uncertainty in the risk assessment. Attachment 1 to this volume provides a detection limit adequacy screen where detection limits for non-detected analytes as well as analytes detected in less than 5 percent of the samples are compared to ESLs. There are 16 analytes in surface soil that have detection limits that exceed the lowest ESLs, but these higher detection limits contribute only minimal uncertainty to the overall risk estimates because either only a small fraction of the detection limits are greater than the lowest ESL, or professional judgment indicates they are not likely to be ECOPCs in LWNEU surface soil even if detection limits had been lower.

10.3.2 Uncertainties Associated with the Lack of Toxicity Data for Ecological Contaminant of Interest Detected at the Lower Walnut Drainage Exposure Unit

Several ECOIs detected in the LWNEU do not have adequate toxicity data for the derivation of ESLs (CRA Methodology). These ECOIs are listed in Tables 7.1, 7.3, and 7.12 with a "UT" designation. Included as a subset of the ECOIs with a "UT" designation are the essential nutrients (calcium, iron, magnesium, potassium, and sodium). Although these nutrients may be potentially toxic to certain ecological receptors at high concentrations, the uncertainty associated with the toxicity of these nutrients is expected to be low. Appendix B of the CRA Methodology outlines a detailed search process that was intended to provide high quality toxicological information for a large proportion of the chemicals detected at RFETS. Although the toxicity is uncertain for those ECOIs that do not have ESLs calculated due to a lack of identified toxicity data, the overall effect on the risk assessment is small because the primary chemicals historically used at RFETS have adequate toxicity data for use in the CRA. Therefore, while the potential for risk from these ECOPCs is uncertain and will tend to underestimate the overall risk calculated, the magnitude of underestimation is likely to be low.

ESLs and/or TRVs were not available for some receptors for the ECOPC identified in Section 7.0. These include plants and invertebrates for 4,4'-DDT. The risks to these ECOPC/receptor pairs are uncertain. The lack of ESLs for some receptors may tend to underestimate potential risks to ecological receptors. However, the magnitude of this underestimation is likely to be low because there are no known RFETS-related sources of 4,4'-DDT in the LWNEU and available ESLs for organics show estimated ecological risks to be minimal to low for those receptors where toxicity information is available. This source of uncertainty is not expected to be significant.

10.3.3 Uncertainties Associated With Eliminating Ecological Contaminants of Interest Based on Professional Judgment

Several analytes in surface soil and subsurface soil were eliminated as ECOIs based on professional judgment. The professional judgment evaluation is intended to identify those ECOIs that have a limited potential for contamination in the LWNEU. The weight-of-evidence approach indicates that there is no identified source or pattern of release in the LWNEU, and the slightly elevated values of the LWNEU data for these ECOIs are most likely due to natural variation. The professional judgment evaluation is unlikely to have significant effect on the overall risk calculations because the ECOIs eliminated from further consideration are found at concentrations in LWNEU that are at levels that are unlikely to result in risk concerns for ecological receptors and are well within regional background levels. In addition, these ECOIs are not related to site-activities in the LWNEU and have very low potential to be transported from historical sources to the LWNEU.

10.4 Summary of Significant Sources of Uncertainty

The preceding discussion outlined the significant sources of uncertainty in the CRA process for assessing ecological risk. While some of the sources of uncertainty discussed tend to either underestimate risk or overestimate risk, many result in an unknown effect on the potential risks. However, the CRA Methodology outlines a tiered process of risk evaluation that includes conservative assumptions for the ECOPC identification process and more realistic assumptions, as appropriate, for risk characterization.

11.0 SUMMARY AND CONCLUSIONS

A summary of the results of this CRA for human health and ecological receptors in the LWNEU is presented below.

11.1 Data Adequacy

The adequacy of the LWNEU data was assessed by comparing the number of samples for each analyte group in each medium as well as the spatial and temporal distributions of the data to data adequacy guidelines. Except for PCBs, the assessment indicates the data meet the data adequacy guidelines. There is limited data for PCBs in surface soil and surface water, and no PCB data for surface soil in the PMJM habitat patches. However, other lines of evidence (e.g., information on potential historical sources of contamination, migration pathways, and the concentration levels in the media) indicate that PCBs are not likely to be present in these LWNEU media, and therefore, are not of concern to human or ecological receptors. Therefore, it is possible to render risk management decisions using the existing data. In addition, for analytes that are not detected or detected at a frequency less than 5 percent, there are several analytes in surface soil that have detection limits that exceed the lowest ESLs, but these higher detection limits contribute only minimal uncertainty to the overall risk estimates because either only a small fraction of the detection limits are greater than the lowest ESL, or professional judgment indicates they are not likely to be ECOPCs in LWNEU surface soil even if detection limits had been lower.

11.2 Human Health

The COC screening analyses compared MDCs and UCLs of chemicals and radionuclides in LWNEU media to PRGs for the WRW receptor. PCOCs with UCLs greater than the PRGs were statistically compared to the background concentration data set. Inorganic analytes that were statistically greater than background at the 0.1 significance level, and organics with UCL concentrations greater than the PRG were carried forward to professional judgment evaluation. Based on the COC selection process, no COCs were selected for surface soil/surface sediment and subsurface soil/subsurface sediment in the LWNEU and a risk characterization was not performed for the LWNEU.

11.3 Ecological Risk

The ECOPC identification process streamlines the ecological risk characterization by focusing the assessment on ECOIs that are present in the LWNEU. The ECOPC identification process is described in the CRA Methodology (DOE 2005a) and additional details are provided in Appendix A, Volume 2 of the RI/FS Report. Only one ECOI in surface soil (4,4'-DDT) was identified as an ECOPC for representative populations of non-PMJM receptors. No ECOPCs were identified for individual PMJM receptors in surface soil. Although there are no dioxin data for surface soil, the evaluation of site-wide data indicate dioxins are not expected to be present in LWNEU surface soil, however, there is some uncertainty in the overall risk estimates for the LWNEU as a result of this data limitation. No ECOPCs were identified in subsurface soil for burrowing receptors.

ECOPC/receptor pairs were evaluated in the risk characterization using conservative default exposure and risk assumptions as defined in the CRA Methodology. Tier 1 and Tier 2 EPCs were used in the risk characterization: Tier 1 EPCs are based on the upper confidence limits of the arithmetic mean concentration for the EU data set and Tier 2 EPCs are calculated using a spatially-weighted averaging approach. If needed, a refinement of the exposure and risk models based on chemical-specific uncertainties associated with the initial default exposure models, provide a refined estimate of potential risk.

Using Tier 1 EPCs and default exposure and risk assumptions, NOAEL HQs ranged from 8 (4,4'-DDT/American kestrel) to 22 (4,4'-DDT/mourning dove-insectivore). NOAEL HQs also ranged from 8 (4,4'-DDT/American kestrel) to 22 (4.4'-DDT/mourning dove-insectivore) using Tier 2 EPCs and default exposure and risk assumptions (Table 10.1).

Both ECOPC/receptor pairs (4,4'-DDT/American kestrel and 4,4'-DDT/mourning dove – insectivore) had LOAEL HQs less than 1 using either Tier 1 or Tier 2 EPCs and the default assumptions used in the risk calculations.

Based on the default calculations, site-related risks are likely to be low for the ecological receptors evaluated in the LWNEU (Table 11.1). In addition, data collected on wildlife abundance and diversity indicate that wildlife species richness remains high at RFETS. There are no significant risks to ecological receptors or high levels of uncertainty with the data, and therefore, there are no ecological contaminants of concern (ECOCs) for the LWNEU.

12.0 REFERENCES

Audubon, 2005. The Missing Birds of Rock Creek Park. Online article under Issues and Actions. <http://www.audubon.org/campaign/population_habitat>. July.

Department of Energy (DOE), 1992. Final Historical Release Report for Rocky Flats Plant, Golden, Colorado. June.

DOE, 1995. Ecological Monitoring Program, 1995 Annual Report. Rocky Flats Field Office, Rocky Flats Environmental Technology Site. Golden Colorado.

DOE, 1996. Final Phase I RFI/RI Report, Woman Creek Priority Drainage, Operable Unit 5, Rocky Flats Environmental Technology Site, Golden, Colorado. April.

DOE, 2004. Comprehensive Risk Assessment Sampling and Analysis Plan Addendum, #04-01, Rocky Flats Environmental Technology Site, Golden, Colorado. March.

DOE, 2005a. Final Comprehensive Risk Assessment Work Plan and Methodology, Rocky Flats Environmental Technology Site, Golden, Colorado. Revision 1. September.

DOE, 2005b. 2005 Annual Update to the Historical Release Report, Rocky Flats Environmental Technology Site, Golden, Colorado.

Ebasco Environmental Consultants, Inc., 1992. Baseline Biological Characterization of the Terrestrial and Aquatic Habitats at Rocky Flats Plant. Prepared for U.S. DOE, Rocky Flats Field Office. Golden, Colorado.

Environmental Protection Agency (EPA), 1997. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments. Interim Final. EPA 540-R-97-006. Solid Waste and Emergency Response. June.

EPA, 2003. Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs). OSWER 9285.7-55. Office of Solid Waste and Emergency Response. December.

EPA, 2005. Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs). Attachment 4-1 Update. Office of Solid Waste and Emergency Response, February.

Fitzgerald, J.P., C.A. Meaney, and D.M. Armstrong, 1994.Mammals of Colorado. University Press of Colorado and Denver Museum of Natural History.467pp.

Interagency Agreement (IAG), 1991. Federal Facility Agreement and Consent Order CERCLA VIII-91-03, RCRA (3008(h)) VIII-91-07 and State of Colorado Docket number 91-01-22-01.

K-H, 1997a. 1996 Annual Wildlife Survey Report for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

K-H, 1997b. Terrestrial Vegetation Survey (1993-1995) for the Rocky Flats Environmental Technology Site, Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

K-H, 1998a. 1997 Annual Wildlife Survey Report for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

K-H, 1998b. 1997 Study of the Preble's Meadow Jumping Mouse at the Rocky Flats Environmental Technology Site. Appendix B, 1997 Annual Wildlife Survey Report for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

K-H, 1999a, 1998. Annual Wildlife Report for the Rocky Flats Environmental Technology Site, Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

K-H, 1999b. 1998 Study of the Preble's Meadow Jumping Mouse at the Rocky Flats Environmental Technology Site. Appendix B, 1998 Annual Wildlife Survey Report for the Rocky Flats Environmental Technology Site, Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

K-H, 2000a, 1999. Annual Wildlife Survey for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

K-H, 2000b. 1999 Study of the Preble's Meadow Jumping Mouse at the Rocky Flats Environmental Technology Site. Appendix B, 1999 Annual Wildlife Survey for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

K-H, 2001. 2000 Annual Wildlife Survey Report for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

K-H, 2002a, 2001. Annual Wildlife Report for the Rocky Flats Environmental Technology Site, Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

K-H, 2002b. 2001 Annual Vegetation Report for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

National Academy of Sciences (NAS), 2000. Dietary Reference Intake Series 1997-2001, Subcommittees on Upper Reference Levels of Nutrients and Interpretation and Uses of DRIs, Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, Food and Nutrition Board. Upper Limits (ULs) Developed from RDIs by the U.S. Food and Drug Administration.

NAS, 2002. Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc. Panel on Micronutrients, Subcommittees on Upper Reference Levels of Nutrients and of Interpretation and Use of Dietary Reference Intakes, and the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes.

Nature Conservancy, 2005. Migratory Bird Program Online Article. Migratory Birds. <http://nature.org/initiatives/programs/birds/>.

PTI, 1997. 1997 Annual Vegetation Report for the Rocky Flats Environmental Technology Site. Prepared by PTI Environmental Services for Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

Rocky Flats Cleanup Agreement (RFCA), 1996. CERCLA Federal Facility Agreement and RCRA/CHWA Consent Order (CERCLA VIII-96-21; RCRA (3008(h)) VIII-96-01; State of Colorado Docket #96-07-19-0).

Todd, A., and M. Sattelberg, 2004. Actinides in Deer Tissue at the Rocky Flats Environmental Technology site. U.S. Fish and Wildlife Service Internal Report.

U.S. Fish and Wildlife Service (USFWS), 2005. Rocky Flats National Wildlife Refuge, Final Comprehensive Conservation Plan. U.S. Fish and Wildlife Service. April.

TABLES

Table 1.1
LWNEU IHSSs

IHSS	OU	PAC	Title	Description	Disposition
142.12	BZ	NE-142.12	Flume Pond (IAG Name: Newly Identified Pond A-5)	The Flume Pond is associated with two Parshall Flumes used for flow measurement.	Proposed for NFAA in the Final Data Summary Report for IHSS Group NE-1 (in preparation).

Table 1.2
Number of Samples in Each Medium by Analyte Suite

Analyte Suite	Surface Soil/Surface Sediment[a]	Subsurface Soil/Subsurface Sediment[a]	Surface Soil[b]	Surface Soil (PMJM)[b]	Subsurface Soil[b]
Inorganics	29	20	23	9	14
Organics	15	21	12	8	16
Radionuclides	81	17	57	12	11

[a] Used in the HHRA.

[b] Used in the ERA.

The total number of results (samples) in Tables 1.3 through 1.7 may differ from the total number of samples presented in Table 1.2 because not all analyses are necessarily performed for each sample.

Table 1.3
Summary of Detected Analytes in Surface Soil/Surface Sediment

Analyte	Range of Reported Detection Limits[a]	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[b]	Standard Deviation[b]
Inorganics (mg/kg)							
Aluminum		25	100	7,460	17,000	11,600	2,490
Antimony	0.31 - 22.9	17	23.5	0.490	1.00	3.20	3.84
Arsenic		25	100	2.20	9.40	5.45	1.56
Barium		25	100	86.4	180	126	23.1
Beryllium	0.73 - 1.4	25	80	0.622	1.30	0.793	0.214
Boron		18	100	2.75	8.40	4.89	1.43
Cadmium	0.038 - 1.7	25	80	0.220	2.20	0.900	0.633
Calcium		25	100	1,160	18,000	5,640	3,680
Chromium		28	100	6.90	21.0	13.3	3.49
Cobalt		28	100	4.30	11.0	7.67	1.52
Copper		28	100	5.00	22.0	13.9	3.22
Iron		28	100	9,520	81,700	18,126	13,535
Lead		28	100	13.0	50.9	23.8	9.79
Lithium		28	100	4.80	17.0	9.87	2.96
Magnesium		28	100	1,490	4,200	2,512	597
Manganese		28	100	130	1,110	286	175
Mercury	0.011 - 0.14	28	53.6	0.013	0.036	0.031	0.019
Molybdenum	0.25 - 8	28	64.3	0.202	5.30	1.14	1.33
Nickel	16.2 - 16.2	28	96.4	7.00	22.0	14.0	3.14
Nitrate / Nitrite	3.4 - 3.84	4	50	0.880	2.50	1.75	0.671
Potassium		28	100	1,490	3,400	2,289	572
Selenium	0.24 - 2.1	28	7.14	0.660	0.780	0.386	0.232
Silica		17	100	710	2,000	1,138	376
Silicon		5	100	283	1,970	1,285	634
Silver	0.078 - 2.7	28	39.3	0.167	1.31	0.602	0.497
Sodium	110 - 270	28	53.6	26.9	790	146	186
Strontium		28	100	23.4	95.0	47.3	16.5
Thallium	0.33 - 1.6	28	7.14	0.610	0.678	0.373	0.174
Tin	0.97 - 37.9	28	35.7	0.289	93.3	6.87	17.9
Titanium		21	100	42.0	150	90.2	30.5
Vanadium		28	100	20.9	52.0	34.0	8.04
Zinc		28	100	36.7	130	60.0	18.2
Organics (µg/kg)							
1,4-Dichlorobenzene[c]	340 - 600	15	53.3	0.450	1.50	107	82.7
2-Butanone	10 - 128	11	18.2	25.0	38.0	50.2	5.99
4,4'-DDT	16 - 29	7	14.3	26.0	26.0	13.3	1.80
Acetone	116 - 210	11	9.09	210	210	81.7	3.82
Benzoic Acid	1,700 - 1,700	7	85.7	220	500	380	6.68
bis(2-ethylhexyl)phthalate	410 - 450	7	57.1	49.0	130	138	77.1
delta-BHC	8.1 - 14	7	14.3	23.0	23.0	8.01	45.8
Di-n-butylphthalate	410 - 600	7	14.3	38.0	38.0	209	5.99
Methylene Chloride	5.8 - 28	11	18.2	1.80	3.10	4.85	19.3
Phenol	340 - 600	7	14.3	110	110	206	120
Tetrachloroethene	5 - 10	11	54.5	0.380	0.420	1.85	229
Toluene	5.8 - 6.4	11	27.3	6.00	18.0	6.01	57.5
Radionuclides (pCi/g)[d]							
Americium-241		71	N/A	-0.022	0.336	0.064	0.070
Cesium-134		5	N/A	0.002	0.110	0.024	0.048
Cesium-137		10	N/A	0.004	1.25	0.597	0.497
Gross Alpha		11	N/A	-2.40	28.3	14.6	8.22
Gross Beta		11	N/A	8.45	33.8	24.2	7.03
Plutonium-239/240		77	N/A	-0.012	1.02	0.164	0.227
Radium-226		8	N/A	0.510	1.16	0.813	0.250
Radium-228		1	N/A	0.930	0.930	0.930	N/A
Strontium-89/90		4	N/A	-0.013	0.240	0.119	0.129
Uranium-233/234		41	N/A	0.351	1.47	0.894	0.249
Uranium-235		41	N/A	-0.093	0.196	0.055	0.063
Uranium-238		41	N/A	0	1.44	0.868	0.293

[a] Values in this column are reported results for nondetects (i.e., U-qualified results).

[b] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[c] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[d] All radionuclide values are considered detects.

N/A = Not applicable.

Table 1.4
Summary of Detected Analytes in Subsurface Soil/Subsurface Sediment

Analyte	Range of Reported Detection Limits[a]	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[b]	Standard Deviation[b]
Inorganics (mg/kg)							
Aluminum		20	100	3,760	17,000	10,257	3,872
Arsenic		20	100	2.50	12.8	5.18	2.44
Barium		20	100	73.6	170	119	26.9
Beryllium	0.47 - 1.1	20	75	0.570	1.30	0.725	0.241
Boron		9	100	3.67	6.40	4.46	0.899
Calcium		20	100	3,450	11,400	6,426	2,291
Cesium[c]	0.81 - 99.1	11	9.09	1.67	1.67	12.7	18.1
Chromium		20	100	3.80	18.0	11.8	4.19
Cobalt		20	100	4.60	21.1	9.15	3.57
Copper		20	100	8.10	18.4	13.6	3.06
Iron		20	100	11,300	26,900	16,085	3,930
Lead		20	100	7.20	24.2	15.6	3.63
Lithium		20	100	3.40	14.6	8.54	3.13
Magnesium		20	100	1,170	4,860	2,777	793
Manganese		20	100	120	706	277	134
Mercury	0.032 - 0.12	20	45	0.011	0.089	0.034	0.020
Molybdenum	0.222 - 6.9	20	15	1.20	7.70	1.38	1.83
Nickel		20	100	7.40	24.7	15.7	4.01
Nitrate / Nitrite	0.65 - 3.52	5	20	2.00	2.00	1.42	0.646
Potassium		20	100	870	2,700	1,518	442
Selenium	0.232 - 1.3	20	20	0.300	0.720	0.348	0.169
Silica[c]		9	100	428	1,700	661	409
Silicon[c]		1	100	65.0	65.0	65.0	N/A
Silver	0.069 - 2.2	20	20	0.914	1.50	0.517	0.468
Sodium	108 - 108	20	95	53.0	1,060	193	221
Strontium		20	100	21.9	74.7	50.2	12.8
Thallium	0.26 - 0.99	20	35	0.210	0.690	0.292	0.149
Tin	1.8 - 74.2	20	40	0.528	0.736	5.34	9.16
Titanium[c]		9	100	70.0	113	88.7	15.9
Uranium	1.77 - 11	9	11.1	10.5	10.5	2.49	3.36
Vanadium		20	100	17.2	39.0	28.7	6.33
Zinc		20	100	38.5	70.0	52.8	9.53
Organics (µg/kg)							
1,4-Dichlorobenzene[c]	400 - 530	13	13	61.5	0.270	0.620	121
2-Butanone	11 - 124	18	19	10.5	8.00	51.0	25.7
Acetone	11 - 130	20	21	19.0	3.00	130	32.1
Benzoic Acid	2,000 - 2,500	5	5	60.0	170	480	445
Benzyl Alcohol	430 - 530	5	5	20.0	41.0	41.0	94.3
bis(2-ethylhexyl)phthalate	400 - 510	5	5	60.0	68.0	170	76.5
Di-n-butylphthalate	430 - 530	5	5	20.0	45.0	45.0	92.6
Methylene Chloride	5 - 26	20	21	52.4	2.60	18.0	3.81
Toluene	5 - 6.2	20	21	38.1	3.00	120	26.4
Radionuclides (pCi/g)[d]							
Americium-241		17	N/A	0	0.850	0.086	0.202
Cesium-134		7	N/A	-0.077	0.200	0.062	0.114
Cesium-137		10	N/A	-0.017	0.200	0.066	0.083
Gross Alpha		14	N/A	9.60	30.3	19.4	6.30
Gross Beta		12	N/A	0	30.7	22.4	8.07
Plutonium-239/240		17	N/A	0.002	2.30	0.240	0.556
Radium-226		5	N/A	0.600	1.20	0.864	0.217
Radium-228		4	N/A	1.10	1.30	1.19	0.086
Strontium-89/90		6	N/A	-0.027	0.470	0.162	0.179
Uranium-233/234		13	N/A	0.512	1.30	0.966	0.219
Uranium-235		13	N/A	0.007	0.110	0.051	0.031
Uranium-238		13	N/A	0.542	1.25	0.965	0.212

[a] Values in this column are reported results for nondetects (i.e., U-qualified results).

[b] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[c] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[d] All radionuclide values are considered detects.

N/A = Not applicable.

Table 1.5
Summary of Detected Analytes in Surface Soil

Analyte	Range of Reported Detection Limits[a]	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[b]	Standard Deviation[b]
Barium		22	100	86.4	180	126	23.0
Beryllium	1.3 - 1.4	22	86.4	0.622	1.30	0.836	0.185
Boron		18	100	2.75	8.40	4.89	1.43
Cadmium	1.3 - 1.3	22	90.9	0.220	2.20	0.933	0.666
Calcium		22	100	1,160	18,000	5,340	3,580
Chromium		22	100	7.92	21.0	13.4	2.97
Cobalt		22	100	4.30	11.0	7.52	1.38
Copper		22	100	5.00	17.5	13.4	2.68
Iron		22	100	9,520	81,700	18,900	15,100
Lead		22	100	13.3	50.9	25.8	10.1
Lithium		22	100	4.80	16.0	9.86	2.54
Magnesium		22	100	1,490	3,400	2,420	493
Manganese		22	100	170	1,110	301	193
Mercury	0.011 - 0.14	22	68.2	0.013	0.036	0.031	0.019
Molybdenum	0.25 - 5.4	22	68.2	0.202	5.30	0.967	1.26
Nickel		22	100	7.00	22.0	14.0	3.02
Nitrate / Nitrite		1	100	0.880	0.880	0.880	N/A
Potassium		22	100	1,550	3,400	2,320	523
Selenium	0.32 - 1.2	22	9.09	0.660	0.780	0.339	0.181
Silica		14	100	710	1,670	1,050	316
Silicon[c]		4	100	1,150	1,970	1,540	344
Silver	0.078 - 2.7	22	40.9	0.167	1.31	0.521	0.508
Sodium	110 - 270	22	45.5	26.9	560	103	136
Strontium		22	100	23.4	82.0	43.7	13.1
Thallium	0.33 - 1.1	22	4.55	0.678	0.678	0.344	0.148
Tin	0.97 - 27.1	22	40.9	0.289	93.3	6.56	19.9
Titanium[c]		18	100	42.0	150	88.0	31.4
Vanadium		22	100	20.9	52.0	34.4	8.11
Zinc		22	100	43.0	77.5	56.1	10.0
Organics (µg/kg)							
1,4-Dichlorobenzene[c]	410 - 450	12	66.7	0.450	1.50	72.2	106
4,4'-DDT	20 - 22	4	25.0	26.0	26.0	14.4	7.76
Benzoic Acid		4	100	220	330	268	51.9
bis(2-ethylhexyl)phthalate	410 - 450	4	25.0	49.0	49.0	174	83.4
delta-BHC	10 - 11	4	25.0	23.0	23.0	9.63	8.92
Methylene Chloride[c]	5.8 - 6.4	8	25.0	1.80	3.10	2.86	0.441
Tetrachloroethene	5.9 - 6	8	75.0	0.380	0.420	1.05	1.19
Radionuclides (pCi/g)[d]							
Americium-241		48	N/A	-0.022	0.295	0.054	0.061
Cesium-134		4	N/A	0.002	0.005	0.003	0.001
Cesium-137		7	N/A	0.100	1.25	0.802	0.449
Gross Alpha		8	N/A	8.20	18.1	13.9	3.97
Gross Beta		8	N/A	17.0	33.8	25.5	5.59
Plutonium-239/240		53	N/A	-0.012	1.02	0.160	0.239
Radium-226		7	N/A	0.510	1.16	0.782	0.253
Strontium-89/90		3	N/A	-0.013	0.240	0.149	0.141
Uranium-233/234		19	N/A	0.351	1.18	0.818	0.207
Uranium-235		19	N/A	-0.093	0.196	0.045	0.083
Uranium-238		19	N/A	0.455	1.19	0.837	0.214

[a] Values in this column are reported results for nondetects (i.e., U-qualified results).

[b] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[c] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[d] All radionuclide values are considered detects.

N/A = Not applicable.

Table 1.6
Summary of Detected Analytes in Surface Soil (PMJM Habitat)

Analyte	Range of Reported Detection Limits[a]	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[b]	Standard Deviation[b]
Inorganics (mg/kg)							
Aluminum		9	100	8,030	17,000	12,019	2,495
Arsenic		9	100	4.8	8.1	5.74	1.11
Barium		9	100	86.4	180	133	24
Beryllium		9	100	0.622	1.1	0.77	0.14
Boron		9	100	2.75	5.73	4.64	0.83
Cadmium		9	100	0.35	1.7	1.43	0.41
Calcium		9	100	2,730	5,840	4,784	974
Chromium		9	100	7.92	21	13.1	3.68
Cobalt		9	100	5.49	9.34	7.79	1.06
Copper		9	100	11.6	17.5	14.36	1.92
Iron		9	100	10,800	23,000	16,411	3,538
Lead		9	100	13.3	29	17.8	4.53
Lithium		9	100	7.87	16	11.3	2.46
Magnesium		9	100	1,490	3,400	2,631	576
Manganese[c]		9	100	175	400	268	65.1
Mercury		9	100	0.02	0.036	0.03	0.005
Molybdenum		9	100	0.202	1.09	0.46	0.33
Nickel		9	100	11.3	18.2	15.3	2.05
Nitrate / Nitrite		1	100	0.88	0.88	0.88	N/A
Potassium[c]		9	100	1,610	3,100	2,077	442
Silica		9	100	800	1,670	1,214	272
Silver		9	78	0.167	1.31	0.54	0.49
Sodium		9	89	26.9	52.2	38.6	9.79
Strontium		9	100	30.3	56	44.8	7.82
Thallium		9	11	0.678	0.678	0.37	0.14
Tin		9	89	0.289	0.638	0.52	0.12
Titanium[c]		9	100	54.5	150	90.5	25.8
Vanadium[c]		9	100	21.5	52	31.6	8.72
Zinc		9	100	44.3	64.7	54.3	7.04
Organics (µg/kg)							
1,4-Dichlorobenzene[c]		8	100	1.8	3.1	2.86	0.44
Methylene Chloride[c]		8	25	1.8	3.1	2.86	0.44
Tetrachloroethene		8	75	0.38	0.42	1.05	1.19
Radionuclides (pCi/g)[d]							
Americium-241		12	N/A	-0.0128	0.122	0.04	0.04
Cesium-137		2	N/A	0.26	0.85	0.56	0.42
Gross Alpha		2	N/A	8.2	18	13.10	6.93
Gross Beta		2	N/A	22	23	22.50	0.71
Plutonium-239/240		12	N/A	0.0056	0.285	0.13	0.09
Radium-226		2	N/A	0.51	0.67	0.59	0.11
Strontium-89/90		2	N/A	0.22	0.24	0.23	0.014
Uranium-233/234		7	N/A	0.541	1.18	0.84	0.21
Uranium-235		7	N/A	-0.0435	0.168	0.046	0.079
Uranium-238		7	N/A	0.6	1.19	0.82	0.18

[a] Values in this column are reported results for nondetects (i.e., U-qualified results).

[b] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[c] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[d] All radionuclide values are considered detects.

N/A = Not applicable.

Table 1.7
Summary of Detected Analytes in Subsurface Soil

Analyte	Reported Detection Limit[a]	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[b]	Standard Deviation[b]
Inorganics (mg/kg)							
Aluminum		14	100	5,250	17,000	10,500	3,800
Arsenic		14	100	3.10	12.8	5.89	2.59
Barium		14	100	73.6	130	109	17.0
Beryllium	0.47 - 0.47	14	92.9	0.570	1.30	0.777	0.232
Boron		8	100	3.67	5.33	4.22	0.567
Calcium		14	100	3,450	11,400	5,830	2,140
Cesium	10.7 - 99.1	6	16.7	1.67	1.67	20.7	21.8
Chromium		14	100	7.50	18.0	12.5	3.76
Cobalt		14	100	4.60	21.1	8.73	4.06
Copper		14	100	8.10	17.3	12.6	2.58
Iron		14	100	11,300	26,900	16,300	4,690
Lead		14	100	12.7	24.2	15.9	3.06
Lithium		14	100	4.90	14.6	8.81	3.08
Magnesium		14	100	1,850	4,860	2,790	817
Manganese		14	100	120	706	285	156
Mercury	0.06 - 0.12	14	64.3	0.011	0.089	0.034	0.023
Molybdenum	0.222 - 4.2	14	21.4	1.20	7.70	1.15	1.97
Nickel		14	100	7.40	24.7	15.7	4.54
Potassium		14	100	870	2,090	1,460	406
Selenium	0.232 - 1.27	14	28.6	0.300	0.720	0.360	0.164
Silica		8	100	428	751	531	133
Silicon		1	100	65.0	65.0	65.0	N/A
Silver	0.069 - 0.84	14	21.4	0.914	1.50	0.388	0.475
Sodium	108 - 108	14	92.9	53.0	1,060	195	264
Strontium		14	100	36.2	74.7	50.0	11.7
Thallium	0.3 - 0.569	14	28.6	0.210	0.340	0.247	0.049
Tin	2.1 - 74.2	14	57.1	0.528	0.736	3.62	9.65
Titanium		8	100	70.0	113	86.0	14.7
Uranium	1.77 - 1.88	8	12.5	10.5	10.5	2.12	3.39
Vanadium		14	100	17.2	36.4	27.8	6.35
Zinc		14	100	38.5	55.9	48.5	6.00
Organics (µg/kg)							
1,4-Dichlorobenzene[c]		8	100	0.270	0.620	0.430	0.129
Acetone	11 - 124	16	18.8	3.00	16.0	32.5	25.6
Methylene Chloride	5 - 6	16	62.5	2.60	6.00	3.36	0.905
Toluene	5 - 6.2	16	31.3	17.0	120	16.2	30.0
Radionuclides (pCi/g)[d]							
Americium-241		11	N/A	0	0.850	0.113	0.250
Cesium-134		5	N/A	-0.077	0.200	0.072	0.136
Cesium-137		5	N/A	-0.017	0.200	0.095	0.106
Gross Alpha		9	N/A	11.0	30.3	19.4	6.67
Gross Beta		7	N/A	0	29.6	21.1	10.1
Plutonium-239/240		11	N/A	0.002	2.30	0.314	0.690
Radium-226		5	N/A	0.600	1.20	0.864	0.217
Radium-228		4	N/A	1.10	1.30	1.19	0.086
Strontium-89/90		5	N/A	-0.027	0.470	0.185	0.190
Uranium-233/234		7	N/A	0.512	1.30	0.940	0.285
Uranium-235		7	N/A	0.007	0.110	0.054	0.039
Uranium-238		7	N/A	0.542	1.25	0.961	0.290

[a] Values in this column are reported results for nondetects (i.e., U-qualified results).

[b] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[c] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[d] All radionuclide values are considered detects.

N/A = Not applicable.

Table 2.1
Essential Nutrient Screen for Surface Soil/Surface Sediment

Analyte	MDC (mg/kg)	Estimated Maximum Daily Intake[a] (mg/day)	RDA/RDI/AI[b] (mg/day)	UL[b] (mg/day)	Retain for PRG Screen?
Calcium	18,000	1.80	500-1,200	2,500	No
Magnesium	3,400	0.340	80-420	65-110	No
Potassium	3,400	0.340	2,000-3,500	N/A	No
Sodium	560	0.056	500-2,400	N/A	No

[a] Based on the MDC and a 100 mg/day soil ingestion rate for a WRW.

[b] RDA/RDI/AI/UL taken from NAS 2000, 2002.

N/A = Not available.

Table 2.2
PRG Screen for Surface Soil/Surface Sediment

Analyte	PRG[a]	MDC	MDC Exceeds PRG?	UCL[b]	UCL Exceeds PRG?	Retain for Detection Frequency Screen?
Inorganics (mg/kg)						
Aluminum	24,800	21,000	No	--	--	No
Antimony	44.4	1.00	No	--	--	No
Arsenic	**2.41**	**9.40**	**Yes**	**5.79**	**Yes**	**Yes**
Barium	2,870	220	No	--	--	No
Beryllium	100	1.30	No	--	--	No
Boron	9,480	11.0	No	--	--	No
Cadmium	91.4	2.20	No	--	--	No
Chromium[c]	28.4	21.0	No	--	--	No
Cobalt	122	11.0	No	--	--	No
Copper	4,440	22.0	No	--	--	No
Iron	33,300	81,700	Yes	22,482	No	No
Lead	1,000	50.9	No	--	--	No
Lithium	2,220	17.0	No	--	--	No
Manganese	419	1,110	Yes	342	No	No
Mercury	32.9	0.036	No	--	--	No
Molybdenum	555	5.30	No	--	--	No
Nickel	2,220	22.0	No	--	--	No
Nitrate / Nitrite[d]	178,000	2.50	No	--	--	No
Selenium	555	0.780	No	--	--	No
Silica	N/A	2,000	UT	--	--	UT
Silicon	N/A	1,970	UT	--	--	UT
Silver	555	1.31	No	--	--	No
Strontium	66,700	95.0	No	--	--	No
Thallium	7.78	0.678	No	--	--	No
Tin	66,700	93.3	No	--	--	No
Titanium	170,000	150	No	--	--	No
Vanadium	111	52.0	No	--	--	No
Zinc	33,300	130	No	--	--	No
Organics (µg/kg)						
1,4-Dichlorobenzene	91,300	1.50	No	--	--	No
2-Butanone	4.64E+07	38.0	No	--	--	No
4,4'-DDT	10,900	26.0	No	--	--	No
Acetone	1.00E+08	210	No	--	--	No
Benzoic Acid	3.21E+08	500	No	--	--	No
bis(2-ethylhexyl)phthalate	214,000	130	No	--	--	No
delta-BHC	570	23.0	No	--	--	No
Di-n-butylphthalate	8.01E+06	38.0	No	--	--	No
Methylene Chloride	272,000	3.10	No	--	--	No
Phenol	2.40E+07	110	No	--	--	No
Tetrachloroethene	6,710	0.420	No	--	--	No
Toluene	3.09E+06	18.0	No	--	--	No
Radionuclides (pCi/g)						
Americium-241	7.69	0.336	No	--	--	No
Cesium-134	**0.080**	**0.110**	Yes	**0.237**	**Yes**	**Yes**
Cesium-137	**0.221**	**1.25**	Yes	**0.885**	**Yes**	**Yes**
Gross Alpha	N/A	28.3	UT	--	--	UT
Gross Beta	N/A	33.8	UT	--	--	UT
Plutonium-239/240	9.80	1.02	No	--	--	No
Radium-226	2.69	1.16	No	--	--	No
Radium-228	**0.111**	**0.930**	**Yes**	**N/A**	**N/A**	**Yes**
Strontium-89/90	13.2	0.240	No	--	--	No
Uranium-233/234	25.3	1.47	No	--	--	No
Uranium-235	1.05	0.196	No	--	--	No
Uranium-238	29.3	1.44	No	--	--	No

[a] The value shown is equal to the most stringent of the PRGs based on a risk of 1E-06 or an HQ of 0.1.

[b] UCL = 95% upper confidence limit on the mean, unless the MDC < UCL, then the MDC is used as the UCL..

[c] The PRG for chromium (VI) is used.

[d] The PRG for nitrate is used.

N/A = Not available.

UT = Uncertain toxicity; no PRG available (assessed in Section 6.0).

-- = Screen not performed because analyte was eliminated from further consideration in a previous COC selection step.

Bold = Analyte retained for further consideration in the next COC selection step.

Table 2.3

Statistical Distributions and Comparison to Background for LWNEU[a]

Analyte	Statistical Distribution Testing Results						Background Comparison		
	Background Data Set			LWNEU Data Set			Test	1-p	Retain as PCOC?
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)			
Surface Soil/Surface Sediment									
Arsenic	**73**	**GAMMA**	**91.8**	**28**	**NORMAL**	**100**	**WRS**	**7.89E-05**	**Yes**
Cesium-134	77	NON-PARAMETRIC	N/A	5	NON-PARAMETRIC	N/A	WRS	0.998	No
Cesium-137	105	NON-PARAMETRIC	N/A	10	NORMAL	N/A	WRS	0.638	No
Radium-228	40	GAMMA	N/A	1	N/A	N/A	WRS	N/A	N/A
Subsurface Soil/Subsurface Sediment									
Radium-228	31	GAMMA	N/A	4	NORMAL	N/A	WRS	0.944	No

[a] EU data used for background comparisons do not include data from background locations.

N/A = Not applicable. Background comparison was not performed because background data were not available or detection frequency for an analyte in EU or background data set is less than 20%.

Table 2.4
Essential Nutrient Screen for Subsurface Soil/Subsurface Sediment

Analyte	MDC (mg/kg)	Estimated Maximum Daily Intake[a] (mg/day)	RDA/RDI/AI[b] (mg/day)	UL[b] (mg/day)	Retain for PRG Screen?
Calcium	11,400	1.14	500-1,200	2,500	No
Magnesium	4,860	0.490	80-420	65-110	No
Potassium	2,700	0.270	2,000-3,500	N/A	No
Sodium	1,060	0.110	500-2,400	N/A	No

[a] Based on the MDC and a 100 mg/day soil ingestion rate for a WRW.

[b] RDA/RDI/AI/UL taken from NAS 2000, 2002.

N/A = Not available.

Table 2.5
PRG Screen for Subsurface Soil/Subsurface Sediment

Analyte	PRG[a]	MDC	MDC Exceeds PRG?	UCL[b]	UCL Exceeds PRG?	Retain for Detection Frequency Screen?
Inorganics (mg/kg)						
Aluminum	285,000	17,000	No	--	--	No
Arsenic	27.7	12.8	No	--	--	No
Barium	33,000	170	No	--	--	No
Beryllium	1,150	1.30	No	--	--	No
Boron	109,000	6.40	No	--	--	No
Cesium	N/A	1.67	UT	--	--	UT
Chromium[c]	327	18	No	--	--	No
Cobalt	1,400	21.1	No	--	--	No
Copper	51,100	18.4	No	--	--	No
Iron	383,000	26,900	No	--	--	No
Lead	1,000	24.2	No	--	--	No
Lithium	25,600	14,600	No	--	--	No
Manganese	4,820	706	No	--	--	No
Mercury	379	0.0890	No	--	--	No
Molybdenum	6,390	7.70	No	--	--	No
Nickel	25,600	24.7	No	--	--	No
Nitrate / Nitrite[d]	2.04E+06	2	No	--	--	No
Selenium	6,390	0.720	No	--	--	No
Silica	N/A	1,700	UT	--	--	UT
Silicon	N/A	65	UT	--	--	UT
Silver	6,390	1.50	No	--	--	No
Strontium	767,000	74.7	No	--	--	No
Thallium	89.4	0.690	No	--	--	No
Tin	767,000	0.736	No	--	--	No
Titanium	1.95E+06	113	No	--	--	No
Uranium	3,830	10.5	No	--	--	No
Vanadium	1,280	39	No	--	--	No
Zinc	383,000	70	No	--	--	No
Organics (µg/kg)						
1,4-Dichlorobenzene	1.05E+06	0.620	No	--	--	No
2-Butanone	5.33E+08	51	No	--	--	No
Acetone	1.15E+09	130	No	--	--	No
Benzoic Acid	3.69E+09	480	No	--	--	No
Benzyl Alcohol	2.76E+08	41	No	--	--	No
bis(2-ethylhexyl)phthalate	2.46E+06	170	No	--	--	No
Di-n-butylphthalate	9.22E+07	45	No	--	--	No
Methylene Chloride	3.13E+06	18	No	--	--	No
Toluene	3.56E+07	120	No	--	--	No
Radionuclides (pCi/g)						
Americium-241	88.4	0.850	No	--	--	No
Cesium-134	0.910	0.200	No	--	--	No
Cesium-137	2.54	0.200	No	--	--	No
Gross Alpha	N/A	30.3	No	--	--	UT
Gross Beta	N/A	30.7	No	--	--	UT
Plutonium-239/240	112	2.30	No	--	--	No
Radium-226	31.0	1.20	No	--	--	No
Radium-228	**1.28**	**1.30**	**Yes**	**1.29**	**Yes**	**Yes**
Strontium-89/90	152	0.470	No	--	--	No
Uranium-233/234	291	1.30	No	--	--	No
Uranium-235	12.1	0.110	No	--	--	No
Uranium-238	337	1.25	No	--	--	No

[a] The value shown is equal to the most stringent of the PRGs based on a risk of 1E-06 or an HQ of 0.1.

[b] UCL = 95% upper confidence limit on the mean, unless the MDC < UCL, then the MDC is used as the UCL..

[c] The PRG for chromium (VI) is used.

[d] The PRG for nitrate is used.

N/A = Not available.

UT = Uncertain toxicity; no PRG available (assessed in Section 6.0).

-- = Screen not performed because analyte was eliminated from further consideration in a previous COC selection step.

Bold = Analyte retained for further consideration in the next COC selection step.

Table 2.6
Summary of the COC Selection Process

Analyte	MDC Exceeds PRG?	UCL Exceeds PRG?	Detection Frequency > 5%[a]	Exceeds 30X the PRG?	Exceeds Background?	Professional Judgment-Retain?	Retain as COC?
Surface Soil/Surface Sediment							
Arsenic	Yes	Yes	Yes	N/A	Yes	No	No
Iron	Yes	No	--	--	--	--	No
Manganese	Yes	No	--	--	--	--	No
Cesium-134	Yes	Yes	Yes	N/A	No	--	No
Cesium-137	Yes	Yes	Yes	N/A	No	--	No
Radium-228	Yes	Yes	Yes	N/A	N/A[b]	No	No
Subsurface Soil/ Subsurface Sediment							
Radium-228	Yes	Yes	Yes	N/A	No	--	No

-- = Screen not performed because analyte was eliminated from further consideration in a previous COC selection step.
N/A = Not applicable.
[a] All radionuclide values are considered detects.
[b] Only one sample was available for this analyte in subsurface soil/subsurface sediment, therefore the analysis could not be performed.

Table 6.1

Detected PCOCs without PRGs in Each Medium by Analyte Suite[a]

Analyte	Surface Soil/Surface Sediment	Subsurface Soil/Subsurface Sediment
Inorganics		
Cesium	N/A	X[b]
Silica	X	X[b]
Silicon	X	X[b]
Radionuclides		
Gross Alpha	X	X
Gross Beta	X	X

[a] Does not include essential nutrients. Essential nutrients without PRGs were evaluated by comparing estimated intakes to recommended intakes.

[b] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

N/A = Not applicable. Analyte not detected or not analyzed.

X = PRG is unavailable.

Table 7.1
Comparison of MDCs in Surface Soil to NOAEL ESLs for Terrestrial Plants, Invertebrates, and Vertebrates in the LWNEU

Analyte	MDC	Terrestrial Plants		Terrestrial Invertebrates		Mourning Dove Herbivore		Mourning Dove Insectivore		American Kestrel		Deer Mouse Herbivore		Deer Mouse Insectivore		Prairie Dog		Mule Deer		Coyote Carnivore		Coyote Generalist		Coyote Insectivore		Terrestrial Receptor[a]		Most Sensitive Receptor	Retain for Further Analysis?
		NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	Results	
Inorganics (mg/kg)																													
Aluminum	17,000	50	**Yes**	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Plant	**Yes**
Antimony	1	5	No	78	No	N/A	N/A	N/A	N/A	N/A	N/A	10	No	0.90	**Yes**	19	No	58	No	138	No	13	No	3.85	No	N/A	N/A	Deer Mouse Insectivore	**Yes**
Arsenic	9.4	10	No	60	No	20	No	164	No	1,028	No	2.57	**Yes**	51	No	9.35	**Yes**	13	No	709	No	341	No	293	No	N/A	N/A	Deer Mouse Herbivore	**Yes**
Barium	180	500	No	330	No	159	**Yes**	357	No	1,317	No	930	No	4,427	No	3,224	No	4,766	No	24,896	No	19,838	No	18,369	No	N/A	N/A	Mourning Dove Herbivore	**Yes**
Beryllium	1.3	10	No	40	No	N/A	N/A	N/A	N/A	N/A	N/A	160	No	6.82	No	211	No	896	No	1072	No	103	No	29	No	N/A	N/A	Deer Mouse Insectivore	No
Boron	8.4	0.5	**Yes**	N/A	N/A	30	No	115	No	167	No	62	No	422	No	237	No	314	No	929	No	6,070	No	1,816	No	N/A	N/A	Plant	**Yes**
Cadmium	2.2	32	No	140	No	28	No	0.71	**Yes**	15	No	60	No	1.56	**Yes**	198	No	723	No	1,360	No	51	No	10	No	N/A	N/A	Mourning Dove Insectivore	**Yes**
Calcium	18,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Chromium[b]	21	1	**Yes**	0.40	**Yes**	25	No	1.34	**Yes**	14	**Yes**	281	No	16	**Yes**	703	No	1,461	No	4,173	No	250	No	69	No	N/A	N/A	Invetebrates	**Yes**
Cobalt	11	13	No	N/A	N/A	278	No	87	No	440	No	1,476	No	363	No	2,461	No	7,902	No	3,785	No	2,492	No	1,519	No	N/A	N/A	Plant	No
Copper	17.5	100	No	50	No	29	No	8.25	**Yes**	164	No	295	No	605	No	838	No	4,119	No	5,459	No	3,000	No	4,641	No	N/A	N/A	Mourning Dove Insectivore	**Yes**
Iron	81,700	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Lead	50.9	110	No	1700	No	50	**Yes**	12	**Yes**	96	No	1,344	No	242	No	1,850	No	9,798	No	8,927	No	3,066	No	1,393	No	N/A	N/A	Mourning Dove Insectivore	**Yes**
Lithium	16	2	**Yes**	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1,882	No	610	No	3,178	No	10,173	No	18,431	No	5,608	No	2,560	No	N/A	N/A	Plant	**Yes**
Magnesium	3,400	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Manganese	1,110	500	**Yes**	N/A	N/A	1,032	**Yes**	2,631	No	9,917	No	486	**Yes**	4,080	No	1,519	No	2,506	No	14,051	No	10,939	No	19,115	No	N/A	N/A	Prairie Dog	**Yes**
Mercury	0.036	0.3	No	0.1	No	0.20	No	1.00E-04	**Yes**	1.57	No	0.44	No	0.18	No	3.15	No	7.56	No	8.18	No	8.49	No	37	No	N/A	N/A	Mourning Dove Insectivore	**Yes**
Molybdenum	5.3	2	**Yes**	N/A	N/A	44	No	6.97	No	77	No	8.68	No	1.90	**Yes**	27	No	44	No	275	No	29	No	8.18	No	N/A	N/A	Deer Mouse Insectivore	**Yes**
Nickel	22	30	No	200	No	44	No	1.24	**Yes**	13	**Yes**	16	**Yes**	0.43	**Yes**	38	No	124	No	91	No	6.02	**Yes**	1.86	**Yes**	N/A	N/A	Deer Mouse Insectivore	**Yes**
Nitrate / Nitrite	0.88	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4,478	No	7,647	No	16,233	No	22,660	No	32,879	No	32,190	No	32,879	No	N/A	N/A	Deer Mouse Herbivore	No
Potassium	3,400	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Selenium	0.78	1	No	70	No	1.61	No	1.00	No	8.48	No	0.87	No	0.75	**Yes**	2.80	No	3.82	No	32	No	12	No	5.39	No	N/A	N/A	Deer Mouse Insectivore	**Yes**
Silica	1,670	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Silicon	1,970	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Silver	1.31	2	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Plant	No
Sodium	560	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Strontium	82	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	940	No	13,578	No	3,519	No	4,702	No	584,444	No	144,904	No	57,298	No	N/A	N/A	Deer Mouse Herbivore	No
Thallium	0.678	1	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	180	No	7.24	No	204	No	1,039	No	212	No	82	No	31	No	N/A	N/A	Plant	No
Tin	93.3	50	**Yes**	N/A	N/A	26	**Yes**	2.90	**Yes**	19	**Yes**	45	**Yes**	3.77	**Yes**	81	**Yes**	242	No	70	**Yes**	36	**Yes**	16	**Yes**	N/A	N/A	Mourning Dove Insectivore	**Yes**
Titanium	150	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Vanadium	52	2	**Yes**	N/A	N/A	503	No	274	No	1,514	No	64	No	30	**Yes**	84	No	358	No	341	No	164	No	121	No	N/A	N/A	Plant	**Yes**
Zinc	77.5	50	**Yes**	200	No	109	No	0.65	**Yes**	113	No	171	No	5.29	**Yes**	1,174	No	2,772	No	16,489	No	3,887	No	431	No	N/A	N/A	Mourning Dove Insectivore	**Yes**
Organics (µg/kg)																													
1,4-Dichlorobenzene	1.5	N/A	N/A	20,000	No	N/A	N/A	N/A	N/A	N/A	N/A	1.71E+06	No	57,635	No	5.93E+06	No	8.65E+06	No	251,050	No	250,513	No	249,682	No	N/A	N/A	Invetebrates	No
4,4'-DDT	26	N/A	N/A	N/A	N/A	226	No	1.20	**Yes**	3.34	**Yes**	72,072	No	379	No	175,708	No	374,883	No	1,873	No	1,808	No	1,644	No	N/A	N/A	Mourning Dove Insectivore	**Yes**
Benzoic Acid	330	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
bis(2-ethylhexyl)phthalate	49	N/A	N/A	N/A	N/A	19,547	No	137	No	398	No	960,345	No	8,071	No	2.76E+06	No	4.93E+06	No	42,305	No	40,167	No	34,967	No	N/A	N/A	Mourning Dove Insectivore	No
delta-BHC	23	N/A	N/A	N/A	N/A	4,687	No	82	No	212	No	1,009	No	26	No	3425	No	5,125	No	117	No	116	No	112	No	N/A	N/A	Deer Mouse Insectivore	No
Methylene Chloride	3.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	58,196	No	3,399	No	209,560	No	294,601	No	13,687	No	13,922	No	14,727	No	N/A	N/A	Deer Mouse Insectivore	No
Tetrachloroethene	0.42	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20,713	No	763	No	72,494	No	105,023	No	3,285	No	3,288	No	3,307	No	N/A	N/A	Deer Mouse Insectivore	No
Radionuclides (pCi/g)																													
Americium-241	0.2946	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3,890	No	Terrestrial Receptors	No
Cesium-134	0.005	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Cesium-137	1.25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20.8	No	Terrestrial Receptors	No
Gross Alpha	18.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Gross Beta	33.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Plutonium-239/240	1.025	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6,110	No	Terrestrial Receptors	No
Radium-226	1.16	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	50.6	No	Terrestrial Receptors	No
Stontium-89/90	0.24	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	22.5	No	Terrestrial Receptors	No
Uranium-233/234	1.18	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4,980	No	Terrestrial Receptors	No
Uranium-235	0.196	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2,770	No	Terrestrial Receptors	No
Uranium-238	1.19	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1,580	No	Terrestrial Receptors	No

[a] Radionuclide ESLs are not receptor-specific. They are considered protective of all terrestrial ecological species.

[b] ESLs for chromium were developed based on available toxicity data and are based on Chromium (III) (birds) and Chromium (VI) (plants, invertebrates, and mammals).

N/A = Indicates no ESL was available for that ECOI/receptor pair.

UT = Uncertain toxicity; no ESL available (assessed in Section 10).

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.2
Summary of Non-PMJM NOAEL ESL Screening Results for Surface Soil in the LWNEU

Analyte	Terrestrial Plant Exceedance?	Terrestrial Invertebrate Exceedance?	Terrestrial Vertebrate Exceedance?
Inorganics			
Aluminum	**Yes**	UT	UT
Antimony	No	No	**Yes**
Arsenic	No	No	**Yes**
Barium	No	No	**Yes**
Beryllium	No	No	No
Boron	**Yes**	UT	No
Cadmium	No	No	**Yes**
Calcium	UT	UT	UT
Chromium	**Yes**	**Yes**	**Yes**
Cobalt	No	UT	No
Copper	No	No	**Yes**
Iron	UT	UT	UT
Lead	No	No	**Yes**
Lithium	**Yes**	UT	No
Magnesium	UT	UT	UT
Manganese	**Yes**	UT	**Yes**
Mercury	No	No	**Yes**
Molybdenum	**Yes**	UT	**Yes**
Nickel	No	No	**Yes**
Nitrate / Nitrite	UT	UT	No
Potassium	UT	UT	UT
Selenium	No	No	**Yes**
Silica	UT	UT	UT
Silicon	UT	UT	UT
Silver	No	UT	UT
Sodium	UT	UT	UT
Strontium	UT	UT	No
Thallium	No	UT	No
Tin	**Yes**	UT	**Yes**
Titanium	UT	UT	UT
Vanadium	**Yes**	UT	**Yes**
Zinc	**Yes**	No	**Yes**
Organics			
1,4-Dichlorobenzene	UT	No	No
4,4'-DDT	UT	UT	**Yes**
Benzoic Acid	UT	UT	UT
bis(2-ethylhexyl)phthalate	UT	UT	No
delta-BHC	UT	UT	No
Methylene Chloride	UT	UT	No

Table 7.2
Summary of Non-PMJM NOAEL ESL Screening Results for Surface Soil in the LWNEU

Analyte	Terrestrial Plant Exceedance?	Terrestrial Invertebrate Exceedance?	Terrestrial Vertebrate Exceedance?
Tetrachloroethene	UT	UT	No
Radionuclides			
Americium-241	UT	UT	No
Cesium-134	UT	UT	UT
Cesium-137	UT	UT	No
Gross Alpha	UT	UT	UT
Gross Beta	UT	UT	UT
Plutonium-239/240	UT	UT	No
Radium-226	UT	UT	No
Strontium-89/90	UT	UT	No
Uranium-233/234	UT	UT	No
Uranium-235	UT	UT	No
Uranium-238	UT	UT	No

UT - Uncertain toxicity; no ESL available (assessed in Section 10).
Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.3
Comparison of MDCs in Surface Soil with NOAEL ESLs for the PMJM in the LWNEU

Analyte	MDC	PMJM NOAEL ESL	EPC > PMJM ESL?
Inorganics (mg/kg)			
Aluminum	17,000	N/A	UT
Arsenic	**8.10**	**2.21**	**Yes**
Barium	180	743	No
Beryllium	1.10	8.16	No
Boron	5.73	52.7	No
Cadmium	1.70	1.75	No
Calcium	5,840	N/A	UT
Chromium[a]	**21**	**19.3**	**Yes**
Cobalt	9.34	340	No
Copper	17.5	95.0	No
Iron	23,000	N/A	UT
Lead	29	220	No
Lithium	16	519	No
Magnesium	3,400	N/A	UT
Manganese	**400**	**388**	**Yes**
Mercury	0.0360	0.052	No
Molybdenum	1.09	1.84	No
Nickel	**18.2**	**0.510**	**Yes**
Nitrate / Nitrite	0.880	2,910	No
Potassium	3,100	N/A	UT
Silica	1,670	N/A	UT
Silver	1.31	N/A	UT
Sodium	52.2	N/A	UT
Strontium	56	833	No
Thallium	0.678	8.64	No
Tin	0.638	4.22	No
Titanium	150	N/A	UT
Vanadium	**52**	**21.6**	**Yes**
Zinc	**64.7**	**6.41**	**Yes**
Organics (µg/kg)			
1,4-Dichlorobenzene	1.50	70,200	No
Methylene Chloride	3.10	4,010	No
Tetrachloroethene	0.420	926	No
Radionuclides (pCi/kg)			
Americium-241	0.122	3,890	No
Cesium-137	0.850	20.8	No
Gross Alpha	18	N/A	UT
Gross Beta	23	N/A	UT
Plutonium-239/240	0.285	6,110	No
Radium-226	0.670	50.6	No
Strontium-89/90	0.240	22.5	No
Uranium-233/234	1.18	4,980	No
Uranium-235	0.168	2,770	No
Uranium-238	1.19	1,580	No

[a] Chromium ESL is based on Chromium (VI).

N/A = No ESL available for the ECOI/receptor pair.

UT = Uncertain toxicity; no ESL available (assessed in Section 10.0).

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.4
Statistical Distribution and Comparison to Background for Surface Soil in the LWNEU

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			LWNEU Data Set					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Retain as ECOI?
Inorganics (mg/kg)									
Aluminum	20	NORMAL	100	22	NORMAL	100	t-Test_N	0.0296	**Yes**
Antimony	20	NON-PARAMETRIC	0	14	NON-PARAMETRIC	28.6	N/A	N/A	**Yes**[a]
Arsenic	20	NORMAL	100	22	NORMAL	100	t-Test_N	0.770	No
Barium	20	NORMAL	100	22	NORMAL	100	t-Test_N	5.06E-04	**Yes**
Boron	N/A	N/A	N/A	18	GAMMA	100	N/A	N/A	**Yes**[a]
Cadmium	20	NON-PARAMETRIC	65	22	NON-PARAMETRIC	90.9	WRS	0.430	No
Chromium	20	NORMAL	100	22	NORMAL	100	t-Test_N	0.00960	**Yes**
Copper	20	NON-PARAMETRIC	100	22	NON-PARAMETRIC	100	WRS	0.303	No
Lead	20	NORMAL	100	22	GAMMA	100	WRS	0.995	No
Lithium	20	NORMAL	100	22	NORMAL	100	t-Test_N	0.00152	**Yes**
Manganese	20	NORMAL	100	22	NON-PARAMETRIC	100	WRS	0.134	No
Mercury	20	NON-PARAMETRIC	40	22	GAMMA	68.2	WRS	1.000	No
Molybdenum	20	NORMAL	0	22	GAMMA	68.2	N/A	N/A	**Yes**[a]
Nickel	20	NORMAL	100	22	NORMAL	100	t-Test_N	4.59E-06	**Yes**
Selenium	20	NON-PARAMETRIC	60	22	NON-PARAMETRIC	9.09	N/A	N/A	**Yes**[a]
Tin	20	NORMAL	0	22	NON-PARAMETRIC	40.9	N/A	N/A	**Yes**[a]
Vanadium	20	NORMAL	100	22	NORMAL	100	t-Test_N	0.00451	**Yes**
Zinc	20	NORMAL	100	22	NORMAL	100	t-Test_N	0.0371	**Yes**
Organics (µg/kg)									
4,4'-DDT	N/A	N/A	N/A	4	NON-PARAMETRIC	25	N/A	N/A	**Yes**[a]

[a] Statistical comparisons to background cannot be performed. The analyte is retained as an ECOI for further evaluation.

N/A = Not applicable; background data not available or not detected.

Test: WRS = Wilcoxon Rank Sum

t-Test_N = Student's t-test using normal data.

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.5
Statistical Distributions and Comparison to Background for Surface Soil in PMJM Habitat in the LWNEU

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			LWNEU Data Set					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Retain as ECOI?
Inorganics (mg/kg)									
Arsenic	20	NORMAL	100	9	NON-PARAMETRIC	100	WRS	0.738	No
Chromium	20	NORMAL	100	9	NORMAL	100	t-Test_N	0.067	**Yes**
Manganese	20	NORMAL	100	9	NORMAL	100	t-Test_N	0.118	No
Nickel	20	NORMAL	100	9	NORMAL	100	t-Test_N	1.88E-06	**Yes**
Vanadium	20	NORMAL	100	9	LOGNORMAL	100	WRS	0.144	No
Zinc	20	NORMAL	100	9	NORMAL	100	t-Test_N	0.156	No

Test: WRS = Wilcoxon Rank Sum, t-Test_N = Student's t-test using normal data

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.6

Statistical Concentrations in Surface Soil in the LWNEU[a]

Analyte	Total Samples	UCL Recommended by ProUCL	Distribution Recommeded by ProUCL	Mean Detected Concentration	Median Detected Concentration	75th Percentile	95th Percentile	UCL	UTL	MDC
Inorganics (mg/kg)										
Aluminum	22	95% Student's-t UCL	NORMAL	11,912	12,000	13,225	14,995	12,801	16,484	17,000
Antimony	14	99% Chebyshev (Mean, Sd) UCL	NON-PARAMETRIC	2.10	0.510	4.90	6.61	9.73	6.80	6.80
Barium	22	95% Student's-t UCL	NORMAL	126	130	140	150	134	169	180
Boron	18	95% Approximate Gamma UCL	GAMMA	4.89	4.66	5.23	7.98	5.50	8.40	8.40
Chromium	22	95% Student's-t UCL	NORMAL	13.4	13.7	15	16.3	14.5	19.0	21
Lithium	22	95% Student's-t UCL	NORMAL	9.86	10	11.5	13.0	10.8	14.7	16
Molybdenum	22	95% Approximate Gamma UCL	GAMMA	0.967	0.500	0.960	2.70	1.48	5.30	5.30
Nickel	22	95% Student's-t UCL	NORMAL	14.0	14	15.3	18.2	15.1	19.7	22
Selenium	22	95% Student's-t UCL	NON-PARAMETRIC	0.339	0.250	0.456	0.657	0.406	0.780	0.780
Tin	22	99% Chebyshev (Mean, Sd) UCL	NON-PARAMETRIC	6.56	0.644	1.05	13.5	48.7	93.3	93.3
Vanadium	22	95% Student's-t UCL	NORMAL	34.4	32.9	38.8	50.6	37.4	49.7	52
Zinc	22	95% Student's-t UCL	NORMAL	56.1	54.7	64.9	71.7	59.8	75.0	77.5
Organics (µg/kg)										
4,4'-DDT	4	95% Student's-t UCL	NON-PARAMETRIC	14.4	10.8	14.8	23.8	23.5	26	26.0

[a] For inorganics and organics, one-half the detection limit used as proxy value for nondetects in computation of the statistical concentrations.

MDC = Maximum detected concentration or in some cases, maximum proxy result.

UCL = 95% upper confidence limit on the mean, unless the MDC<UCL, then the MDC is used as the UCL.

UTL = 95% upper confidence limit on the 90th percentile value, unless the MDC<UTL, then the MDC is used as the UTL.

Table 7.7
Upper-Bound Exposure Point Concentration Comparison to Limiting ESLs in the LWNEU

Analyte	Small Home Range Receptors			Large Home Range Receptors		
	EPC (UTL)	Limiting ESL[a]	EPC>ESL?	EPC (UCL)	Limiting ESL[b]	EPC>ESL?
Inorganics (mg/kg)						
Aluminum	16,484	50	**Yes**	12,801	N/A	N/A
Antimony	6.80	0.90	**Yes**	9.73	3.85	**Yes**
Barium	169	222	No	134	4,770	No
Boron	8.40	0.5	**Yes**	5.50	314	No
Chromium[c]	19.0	0.4	**Yes**	14.5	68.5	No
Lithium	14.7	2	**Yes**	10.8	2,560	No
Molybdenum	5.30	1.9	**Yes**	1.48	8.18	No
Nickel	19.7	0.431	**Yes**	15.1	1.86	**Yes**
Selenium	0.780	0.75	**Yes**	0.406	3.82	No
Tin	93.3	2.90	**Yes**	48.7	16	**Yes**
Vanadium	49.7	2	**Yes**	37.4	121	No
Zinc	75.0	0.646	**Yes**	59.8	431	No
Organics (µg/kg)						
4,4'-DDT	26	1.2	**Yes**	23.5	1,640	No

[a] Threshold ESL (if available) for the plant, invertebrate, deer mouse, prarie dog, dove, or kestrel receptors.

[b] Threshold ESL (if available) for the coyote and mule deer receptors.

[c] The ESLs for chromium were developed based on available toxicity data and are based on chromium (III) (birds) and chromium (VI) (plants, invertebrates, and mammals).

N/A = Not applicable; ESL not available (assessed in Section 10).

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.8
Upper-Bound Exposure Point Concentration Comparison to Receptor-Specific ESLs for Small Home-Range Receptors in the LWNEU

Analyte	Small Home Range Receptor UTL	Receptor-Specific ESLs[a]							
		Terrestrial Plant	Terrestrial Invertebrate	American Kestrel	Mourning Dove (herbivore)	Mourning Dove (insectivore)	Deer Mouse (herbivore)	Deer Mouse (insectivore)	Prairie Dog
Inorganics (mg/kg)									
Aluminum	16,484	**50**	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Antimony	6.80	**5**	78	N/A	N/A	N/A	10	**0.90**	19
Boron	8.40	**0.5**	N/A	167	30	115	62	422	237
Chromium	19.0	**1**	**0.4**	**14.2**	24.6	**1.34**	281	**15.9**	703
Lithium	14.7	**2**	N/A	N/A	N/A	N/A	1,880	610	3,180
Molybdenum	5.30	**2**	N/A	76.7	44.4	6.97	8.68	**1.90**	27.1
Nickel	19.7	30	200	89.9	320	**7.84**	**16.4**	**0.431**	38.3
Selenium	0.780	1	70	8.48	1.61	1.00	0.87	**0.75**	2.80
Tin	93.3	**50**	N/A	**19**	**26**	**2.90**	**45**	**3.77**	**81**
Vanadium	49.7	**2**	N/A	1,514	503	274	64	**30**	84
Zinc	75.0	**50**	200	113	109	**0.65**	171	**5.29**	1,174
Organics (µg/kg)									
4,4'-DDT	26	N/A	N/A	**3.34**	226	**1.20**	72,072	379	175,708

[a]Lowest ESL (threshold if available) for that receptor.
N/A = Not applicable; ESL not available (assessed in Section 10).
Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.9

Upper-Bound Exposure Point Concentration Comparison to Receptor-Specific ESLs for Large Home Range Receptors in the LWNEU

Analyte	Largel Home Range Receptor UCL	Receptor-Specific ESLs[a]			
		Mule Deer	Coyote (carnivore)	Coyote (generalist)	Coyote (insectivore)
Inorganics (mg/kg)					
Antimony	9.73	58	138	13	**3.85**
Nickel	15.1	124	91	**6.02**	**1.86**
Tin	48.7	242	70	**36**	**16**

[a] Threshold ESL (if available) for that receptor.

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.10
Summary of ECOPC Screening Steps for Surface Soil Non-PMJM Receptors in the LWNEU

Analyte	Exceeds Any NOAEL ESL?	Detection Frequency >5%?	Exceeds Background?[a]	Upper Bound EPC > Limiting ESL	Professional Judgment - Retain?	ECOPC?	Receptor(s) of Potential Concern
Inorganics							
Aluminum	Yes	Yes	Yes	Yes	No	No	--
Antimony	Yes	Yes	N/A	Yes	No	No	--
Arsenic	Yes	Yes	No	--	--	No	--
Barium	Yes	Yes	Yes	No	--	No	--
Beryllium	No	--	--	--	--	No	--
Boron	Yes	Yes	N/A	Yes	No	No	--
Cadmium	Yes	Yes	No	--	--	No	--
Calcium	UT	--	--	--	--	No	--
Chromium	Yes	Yes	Yes	Yes	No	No	--
Cobalt	No	--	--	--	--	No	--
Copper	Yes	Yes	No	--	--	No	--
Iron	UT	--	--	--	--	No	--
Lead	Yes	Yes	No	--	--	No	--
Lithium	Yes	Yes	Yes	Yes	No	No	--
Magnesium	UT	--	--	--	--	No	--
Manganese	Yes	Yes	No	--	--	No	--
Mercury	Yes	Yes	No	--	--	No	--
Molybdenum	Yes	Yes	N/A	Yes	No	No	--
Nickel	Yes	Yes	Yes	Yes	No	No	--
Nitrate / Nitrite	No	--	--	--	--	No	--
Potassium	UT	--	--	--	--	No	--
Selenium	Yes	Yes	N/A	Yes	No	No	--
Silica	UT	--	--	--	--	No	--
Silicon	UT	--	--	--	--	No	--
Silver	No	--	--	--	--	No	--
Sodium	UT	--	--	--	--	No	--
Strontium	No	--	--	--	--	No	--
Thallium	No	--	--	--	--	No	--
Tin	Yes	Yes	N/A	Yes	No	No	--
Titanium	UT	--	--	--	--	No	--
Vanadium	Yes	Yes	Yes	Yes	No	No	--
Zinc	Yes	Yes	Yes	Yes	No	No	--
Organics							
1,4-Dichlorobenzene	No	--	--	--	--	No	--
4,4'-DDT	**Yes**	**Yes**	**N/A**	**Yes**	**Yes**	**Yes**	American kestrel Mourning dove (insectivore)
Benzoic Acid	UT	--	--	--	--	No	--
bis(2-ethylhexyl)phthalate	No	--	--	--	--	No	--
delta-BHC	No	--	--	--	--	No	--
Methylene Chloride	No	--	--	--	--	No	--
Tetrachloroethene	No	--	--	--	--	No	--
Radionuclides							

Table 7.10
Summary of ECOPC Screening Steps for Surface Soil Non-PMJM Receptors in the LWNEU

Analyte	Exceeds Any NOAEL ESL?	Detection Frequency >5%?	Exceeds Background?[a]	Upper Bound EPC > Limiting ESL	Professional Judgment - Retain?	ECOPC?	Receptor(s) of Potential Concern
Americium-241	No	--	--	--	--	No	--
Cesium-134	UT	--	--	--	--	No	--
Cesium-137	No	--	--	--	--	No	--
Gross Alpha	UT	--	--	--	--	No	--
Gross Beta	UT	--	--	--	--	No	--
Plutonium-239/240	No	--	--	--	--	No	--
Radium-226	No	--	--	--	--	No	--
Strontium-89/90	No	--	--	--	--	No	--
Uranium-233/234	No	--	--	--	--	No	--
Uranium-235	No	--	--	--	--	No	--
Uranium-238	No	--	--	--	--	No	--

[a] Based on results of statistical analysis at the 0.1 level of significance.

-- = Screen not performed because ECOI was eliminated from further consideration in a previous step.

N/A = Not applicable; background comparison could not be conducted.

UT = Uncertain toxicity; no ESL available (assessed in Section 10).

Bold = Chemicals retained as ECOPCs for further risk characterization.

Table 7.11
Summary of ECOPC Screening Steps for Surface Soil PMJM Receptors in the LWNEU

Analyte	Exceed PMJM NOAEL ESL?	Exceeds Background[a]?	Professional Judgment - Retain?	ECOPC?
Inorganics				
Aluminum	UT	--	--	No
Arsenic	Yes	No	--	No
Barium	No	--	--	No
Beryllium	No	--	--	No
Boron	No	--	--	No
Cadmium	No	--	--	No
Calcium	UT	--	--	No
Chromium	Yes	Yes	No	No
Cobalt	No	--	--	No
Copper	No	--	--	No
Iron	UT	--	--	No
Lead	No	--	--	No
Lithium	No	--	--	No
Magnesium	UT	--	--	No
Manganese	Yes	--	--	No
Mercury	No	--	--	No
Molybdenum	No	--	--	No
Nickel	Yes	Yes	No	No
Nitrate / Nitrite	No	--	--	No
Potassium	UT	--	--	No
Silica	UT	--	--	No
Silver	UT	--	--	No
Sodium	UT	--	--	No
Strontium	No	--	--	No
Thallium	No	--	--	No
Tin	No	--	--	No
Titanium	UT	--	--	No
Vanadium	Yes	No	--	No
Zinc	Yes	No	--	No
Organics				
1,4-Dichlorobenzene	No	--	--	No
Methylene Chloride	No	--	--	No
Tetrachloroethene	No	--	--	No
Radionuclides				
Americium-241	No	--	--	No
Cesium-137	No	--	--	No
Gross Alpha	UT	--	--	No
Gross Beta	UT	--	--	No
Plutonium-239/240	No	--	--	No
Radium-226	No	--	--	No
Strontium-89/90	No	--	--	No
Uranium-233/234	No	--	--	No
Uranium-235	No	--	--	No
Uranium-238	No	--	--	No

[a] Based on results of statistical analysis at the 0.1 level of significance.
-- = Screen not performed because ECOI was eliminated from further consideration in a previous step.
UT = Uncertain toxicity; no ESL available (assessed in Section 10).

Table 7.12
Comparison of MDCs in Subsurface Soil to NOAEL ESLs for Burrowing Receptors in the LWNEU

Analyte	MDC	Prairie Dog NOAEL ESL	MDC> ESL?
Inorganics (mg/kg)			
Aluminum	17,000	N/A	UT
Arsenic	12.8	9.35	**Yes**
Barium	130	3,220	No
Beryllium	1.30	211	No
Boron	5.33	237	No
Calcium	11,400	N/A	UT
Cesium	1.67	N/A	UT
Chromium[a]	18.0	703	No
Cobalt	21.1	2,460	No
Copper	17.3	838	No
Iron	26,900	N/A	UT
Lead	24.2	1,850	No
Lithium	14.6	3,180	No
Magnesium	4,860	N/A	UT
Manganese	706	1519	No
Mercury	0.089	3.15	No
Molybdenum	7.70	27.1	No
Nickel	24.7	38.3	No
Potassium	2,090	N/A	UT
Selenium	0.720	2.80	No
Silica	751	N/A	UT
Silicon	65.0	N/A	UT
Silver	1.50	N/A	UT
Sodium	1,060	N/A	UT
Strontium	74.7	3,520	No
Thallium	0.340	204	No
Tin	0.736	80.6	No
Titanium	113	N/A	UT
Uranium	10.5	1,230	No
Vanadium	36.4	83.5	No
Zinc	55.9	1,170	No
Organics (µg/kg)			
1,4-Dichlorobenzene	0.620	5.93E+06	No
Acetone	16.0	248,000	No
Methylene Chloride	6.00	210,000	No
Toluene	120	1.22E+06	No
Radionuclides (pCi/g)			
Americium-241	0.850	3,890	No
Cesium-134	0.200	N/A	UT
Cesium-137	0.200	20.8	No
Gross Alpha	30.3	N/A	UT
Gross Beta	29.6	N/A	UT
Plutonium-239/240	2.30	6,110	No
Radium-226	1.20	50.6	No
Radium-228	1.30	43.9	No
Strontium-89/90	0.470	22.5	No
Uranium-233/234	1.30	4,980	No
Uranium-235	0.110	2,770	No
Uranium-238	1.25	1,580	No

[a] Chromium ESL is based on Chromium (VI).
N/A = No ESL was available for that ECOI/receptor pair.
UT = Uncertain toxicity; no ESL available (assessed in Section 10).
Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.13
Statistical Distributions and Comparison to Background for Subsurface Soil in the LWNEU

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			LWNEU Data Set					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Retain as ECOI?
Arsenic	45	NONPARAMETRIC	93.3	14	NONPARAMETRIC	100	WRS	0.094	**Yes**

WRS = Wilcoxon Rank Sum.

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.14

Statistical Concentrations in Subsurface Soil in the LWNEU[a]

Analyte	Total Samples	UCL Recommended by ProUCL	Distribution Recommended by ProUCL	Mean	Median	75th Percentile	95th Percentile	UCL	UTL	MDC
Inorganics (mg/kg)										
Arsenic	14	95% Student's-t UCL	NON-PARAMETRIC	5.89	5.29	5.64	11.3	7.11	12.8	12.8

[a] One-half the detection limit used as proxy value for nondetects in computation of the statistical concentrations.

MDC = Maximum detected concentration or in some cases, maximum proxy result.

UCL = 95% upper confidence limit on the mean, unless the MDC<UCL, then the MDC is used as the UCL.

UTL = 95% upper confidence limit on the 90th percentile value, unless the MDC<UTL, then the MDC is used as the UTL.

Table 7.15
Upper-Bound Exposure Point Concentration Comparison to tESLs in the LWNEU

Analyte	Burrowing Receptor		
	EPC (UTL)	tESL[a]	EPC>ESL?
Inorganics (mg/kg)			
Arsenic	**12.8**[b]	**35.90**	**No**

[a] Threshold ESL (if available) for the prairie dog receptor.

[b] The MDC was used as the EPC because the 95UTL was greater than the MDC.

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.16
Summary of ECOPC Screening Steps for Subsurface Soil in the LWNEU

Analyte	Exceed Prairie Dog NOAEL ESL?	Detection Frequency >5%?	Exceeds Background?[a]	Upper Bound EPC > Limiting ESL?	Professional Judgment - Retain?	Retain as ECOPC?
Inorganics						
Aluminum	UT	--	--	--	--	No
Arsenic	Yes	Yes	Yes	No	--	No
Barium	No	--	--	--	--	No
Beryllium	No	--	--	--	--	No
Boron	No	--	--	--	--	No
Calcium	UT	--	--	--	--	No
Cesium	UT	--	--	--	--	No
Chromium	No	--	--	--	--	No
Cobalt	No	--	--	--	--	No
Copper	No	--	--	--	--	No
Iron	UT	--	--	--	--	No
Lead	No	--	--	--	--	No
Lithium	No	--	--	--	--	No
Magnesium	UT	--	--	--	--	No
Manganese	No	--	--	--	--	No
Mercury	No	--	--	--	--	No
Molybdenum	No	--	--	--	--	No
Nickel	No	--	--	--	--	No
Potassium	UT	--	--	--	--	No
Selenium	No	--	--	--	--	No
Silica	UT	--	--	--	--	No
Silicon	UT	--	--	--	--	No
Silver	UT	--	--	--	--	No
Sodium	UT	--	--	--	--	No
Strontium	No	--	--	--	--	No
Thallium	No	--	--	--	--	No
Tin	No	--	--	--	--	No
Titanium	UT	--	--	--	--	No
Uranium	No	--	--	--	--	No
Vanadium	No	--	--	--	--	No
Zinc	No	--	--	--	--	No

Table 7.16
Summary of ECOPC Screening Steps for Subsurface Soil in the LWNEU

Analyte	Exceed Prairie Dog NOAEL ESL?	Detection Frequency >5%?	Exceeds Background?[a]	Upper Bound EPC > Limiting ESL?	Professional Judgment - Retain?	Retain as ECOPC?
Organics						
1,4-Dichlorobenzene	No	--	--	--	--	No
Acetone	No	--	--	--	--	No
Methylene Chloride	No	--	--	--	--	No
Toluene	No	--	--	--	--	No
Radionuclides						
Americium-241	No	--	--	--	--	No
Cesium-134	UT	--	--	--	--	No
Cesium-137	No	--	--	--	--	No
Gross Alpha	UT	--	--	--	--	No
Gross Beta	UT	--	--	--	--	No
Plutonium-239/240	No	--	--	--	--	No
Radium-226	No	--	--	--	--	No
Radium-228	No	--	--	--	--	No
Strontium-89/90	No	--	--	--	--	No
Uranium-233/234	No	--	--	--	--	No
Uranium-235	No	--	--	--	--	No
Uranium-238	No	--	--	--	--	No

[a] Based on results of statistical analysis at the 0.1 level of significance.

'-- = Screen not performed because analyte was eliminated from further consideration in a previous ECOPC selection step.

N/A = Not applicable; background comparison could not be conducted.

UT - Uncertain toxicity; no ESL available (assessed in Section 10).

Table 8.1
Summary of ECOPC/Receptor Pairs

ECOPC	Receptors of Potential Concern
Surface Soil	
4,4'-DDT	American Kestrel Mourning Dove (insectivore)
Surface Soil - PMJM	
None	None
Subsurface Soil	
None	None

Table 8.2
Surface Soil Exposure Point Concentrations for Non-PMJM Receptors

ECOPC	Tier I Exposure Point Concentrations		Tier II Exposure Point Concentrations	
	UTL	UCL	UTL	UCL
Organics (µg/kg)				
4,4'-DDT	26[a]	23.5	26[b]	23.5

[a]Tier 1 UTL was greater than the MDC, so the MDC was used as the proxy exposure point concentration.

[b]Tier 2 soil UTL and/or UCL was greater than the maximum grid average, or could not be calculated due to low numbers of samples, so the maximum grid average was used as a proxy exposure point concentration.

Table 8.3
Surface Water Exposure Point Concentrations for Non-PMJM Receptors

ECOPC	UTL	UCL
Organics (µg/L)		
4,4'-DDT	N/A	N/A

N/A = Data were not available. 4,4'-DDT was not detected in surface water.

Table 8.4
Receptor-Specific Exposure Parameters

Receptor	Body Weight (kg)	Body Weight Reference	Percentage of Diet				Food Ingestion Rate (kg/kg BW day^{-1})	Ingestion Rate Reference	Water Ingestion Rate (L/kg BW day^{-1})	Ingestion Rate Reference	Percentage of Diet as Soil	Soil Ingestion Reference
			Plant Tissue	Invertebrate Tissue	Bird or Mammal Tissue	Dietary Reference						
Vertebrate Receptors												
American Kestrel	0.116	Brown and Amadon (1968) - Average value	0	20	80	Generalized Diet from several studies presented in the Watershed ERA (DOE 1996)	0.092	Koplin et al. (1980)	0.12	EPA (1993) - Estimated using model for all birds - Calder and Braun (1983)	5	Assumed value based on conservative estimates for carnivores
Mourning Dove - Insectivore	0.113	Average of adult values from CalEPA (2004) Online Database	0	100	0	Generalized Diet	0.23	EPA (2003)	0.12	EPA (1993) - Estimated using model for all birds - Calder and Braun (1983)	9.3	Beyer et al (1994) - Wild turkey used as a surrogate.

Receptor parameters for all receptors with the exception of the Prairie Dog and the Mourning Dove were taken from the Watershed Risk Assessment (DOE 1996) and referenced to the original source.
All receptor parameters are estimates of central tendency except where noted.
All values are presented in a dry weight basis.

Table 8.5
Receptor-Specific Intake Estimates

	Intake Estimates (mg/kg BW day)					
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Default Exposure Estimates						
4,4'-DDT						
Mourning Dove - Insectivore						
Tier 1 UTL[a]	N/A	1.94E-01	N/A	5.56E-04	N/A	1.94E-01
Tier 2 UTL[b]	N/A	1.94E-01	N/A	5.56E-04	N/A	1.94E-01
American Kestrel						
Tier 1 UTL[a]	N/A	1.55E-02	5.44E-02	1.20E-04	N/A	7.01E-02
Tier 2 UTL[b]	N/A	1.55E-02	5.44E-02	1.20E-04	N/A	7.01E-02

Table 9.1
TRVs for Terrestrial Vertebrate Receptors

Analyte	NOAEL (mg/kg day)	NOAEL Endpoint	LOAEL (mg/kg day)	LOAEL Endpoint	TRV Source	Uncertainty Factor	Final NOAEL (mg/kg day)	TRV Confidence
Birds								
4,4-DDT	0.009	NOAEL was estimated from LOAEL	1.5	Increase in reproductive effects in mallards	PRC (1994)	1	0.009	High

Threshold TRVs were independently calculated using the procedures outline in the CRA Methodology, Section 3.1.4.

TRV Confidence:

NA = No TRV has been identified or the TRV has been deemed unacceptable for use in ECOPC selection.

Low = TRVs that have data for only one species looking at one endpoint (non-mortality) and from one primary literature source.

Moderate = TRVs that have multiple primary literature sources looking at one endpoint (non-mortality or mortality) but with only one species evaluated.

Good = For TRVs that have either multiple species with one endpoint from multiple studies or those TRVs with multiple species and multiple endpoints from only one study.

High = For TRVs that have multiple study sources looking at multiple endpoints and more than one species.

Very High = All EcoSSLs (EPA 2003a) will be assigned this level of confidence by default.

Table 10.1
Hazard Quotient Summary for Non-PMJM Receptors

ECOPC	Receptor	BAF	EPC	Hazard Quotients (HQs)	
				Based on Default TRVs	Based on Refined Analysis
4,4'-DDT	Mourning Dove (Insectivore)	Default	Tier 1	***NOAEL*** UTL[a] = 22 ***LOAEL*** UTL[a] = 0.1	Not Calculated
			Tier 2	***NOAEL*** UTL[a] = 22 ***LOAEL*** UTL[a] = 0.1	Not Calculated
		Median	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated
	American kestrel	Default	Tier 1	***NOAEL*** UTL[a] = 8 ***LOAEL*** UTL[a] = 0.05	Not Calculated
			Tier 2	***NOAEL*** UTL[a] = 8 ***LOAEL*** UTL[a] = 0.05	Not Calculated
		Median	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated

[a] Soil UTL was greater than the MDC (Tier 1) or the maximum grid average (Tier 2), or could not be calculated due to low numbers of samples, so the MDC (Tier 1) or maximum grid average (Tier 2) was used as a proxy value to calculate intake.
Shaded cells represent default HQ calculations based on exposure and toxicity models specifically identified in the CRA Methodology.
All HQ Calculations are provided in Attachment 4.
Discussion of the chemical-specific uncertainties is provided in Attachment 5.

Table 10.2
Tier 2 Grid Cell Hazard Quotients for Surface Soil in LWNEU

ECOPC	Most Sensitive Receptor	Number of Grid Cells	Percent of Tier 2 Grid Means											
			NOAEL TRV				Threshold TRV				LOAEL TRV			
			HQ < 1	HQ > 1 <5	HQ > 5 <10	HQ > 10	HQ < 1	HQ > 1 <5	HQ > 5 <10	HQ > 10	HQ < 1	HQ > 1 <5	HQ > 5 <10	HQ > 10
4,4'-DDT	Mourning Dove - Insectivore	8	0	0	0	100	N/A	N/A	N/A	N/A	100	0	0	0

N/A = No value available.
The limiting receptor is chosen as the receptor with the lowest ESL.
Default exposure model and TRVs used.

Table 11.1
Summary of Risk Characterization Results for the LWNEU

Analyte	Ecological Receptors	Result of Risk Characterization	Risk Description Conclusion
Surface Soil Non-PMJM Receptors			
4,4'-DDT	Terrestrial Plants	Not an ECOPC[a]	ECOPC of Uncertain Risk
	Terrestrial Invertebrate	Not an ECOPC[a]	ECOPC of Uncertain Risk
	American Kestrel	NOAEL HQs >1 for default scenarios LOAEL HQs <1 for default scenarios	Low Risk
	Mourning Dove (herbivore)	Not an ECOPC	Not an ECOPC
	Mourning Dove (Insectivore)	NOAEL HQs >1 for default scenarios LOAEL HQs <1 for default scenarios	Low Risk
	Deer Mouse (herbivore)	Not an ECOPC	Not an ECOPC
	Deer Mouse (Insectivore)	Not an ECOPC	Not an ECOPC
	Prairie Dog	Not an ECOPC	Not an ECOPC
	Coyote (carnivore)	Not an ECOPC	Not an ECOPC
	Coyote (generalist)	Not an ECOPC	Not an ECOPC
	Coyote (insectivore)	Not an ECOPC	Not an ECOPC
	Mule Deer	Not an ECOPC	Not an ECOPC
Surface Soil - PMJM Receptors			
None	Preble's Meadow Jumping Mouse	No ECOPCs	No ECOPCs
Subsurface Soil			
None	Prairie Dog	No ECOPCs	No ECOPCs

[a]ESL was not available. Analyte evaluated in Section 10.

FIGURES

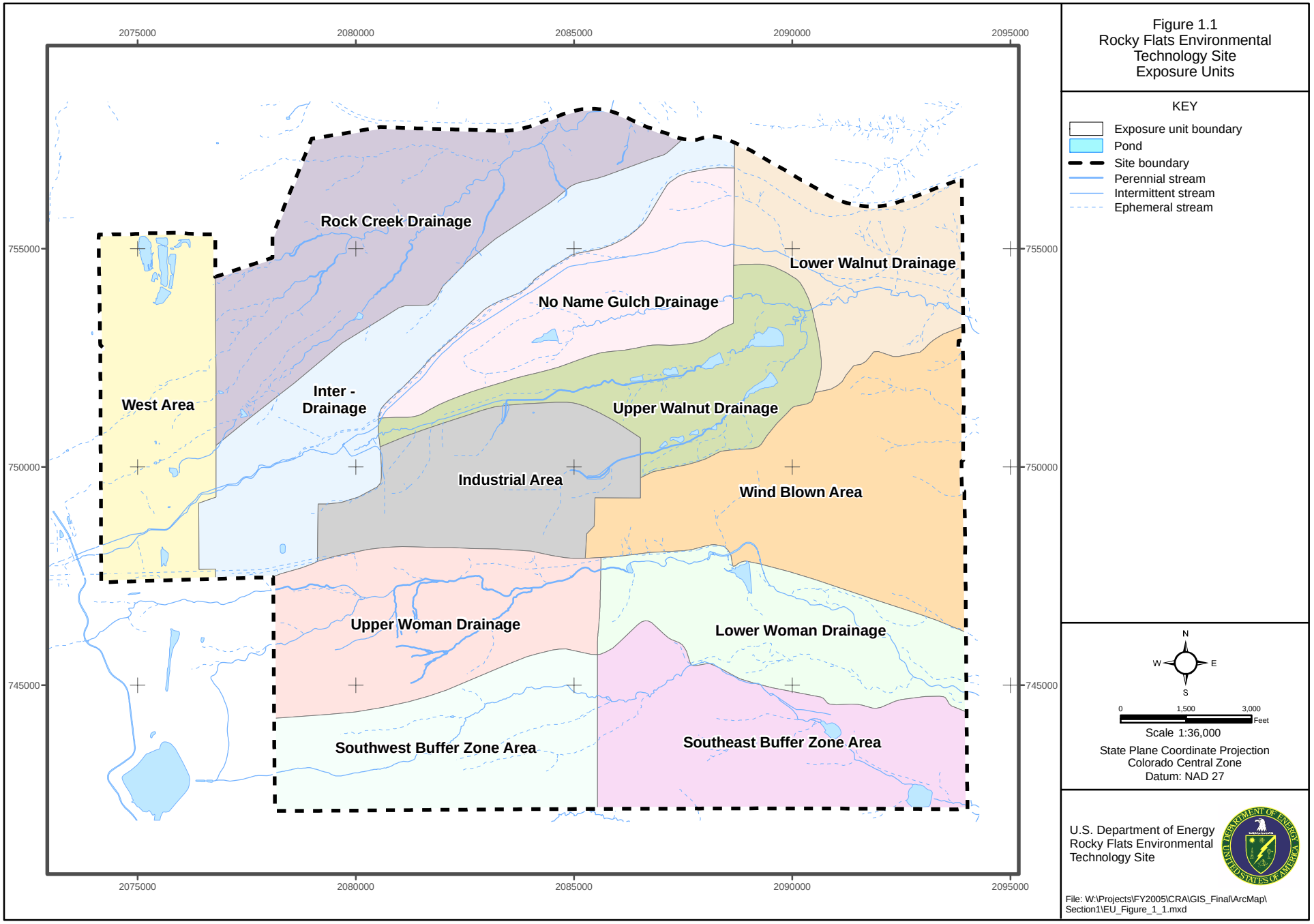


Figure 1.1
Rocky Flats Environmental
Technology Site
Exposure Units

KEY

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W E
S

0 1,500 3,000 Feet

Scale 1:36,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental
Technology Site

File: W:\Projects\FY2005\CRA\GIS_Final\ArcMap\
Section1\EU_Figure_1_1.mxd

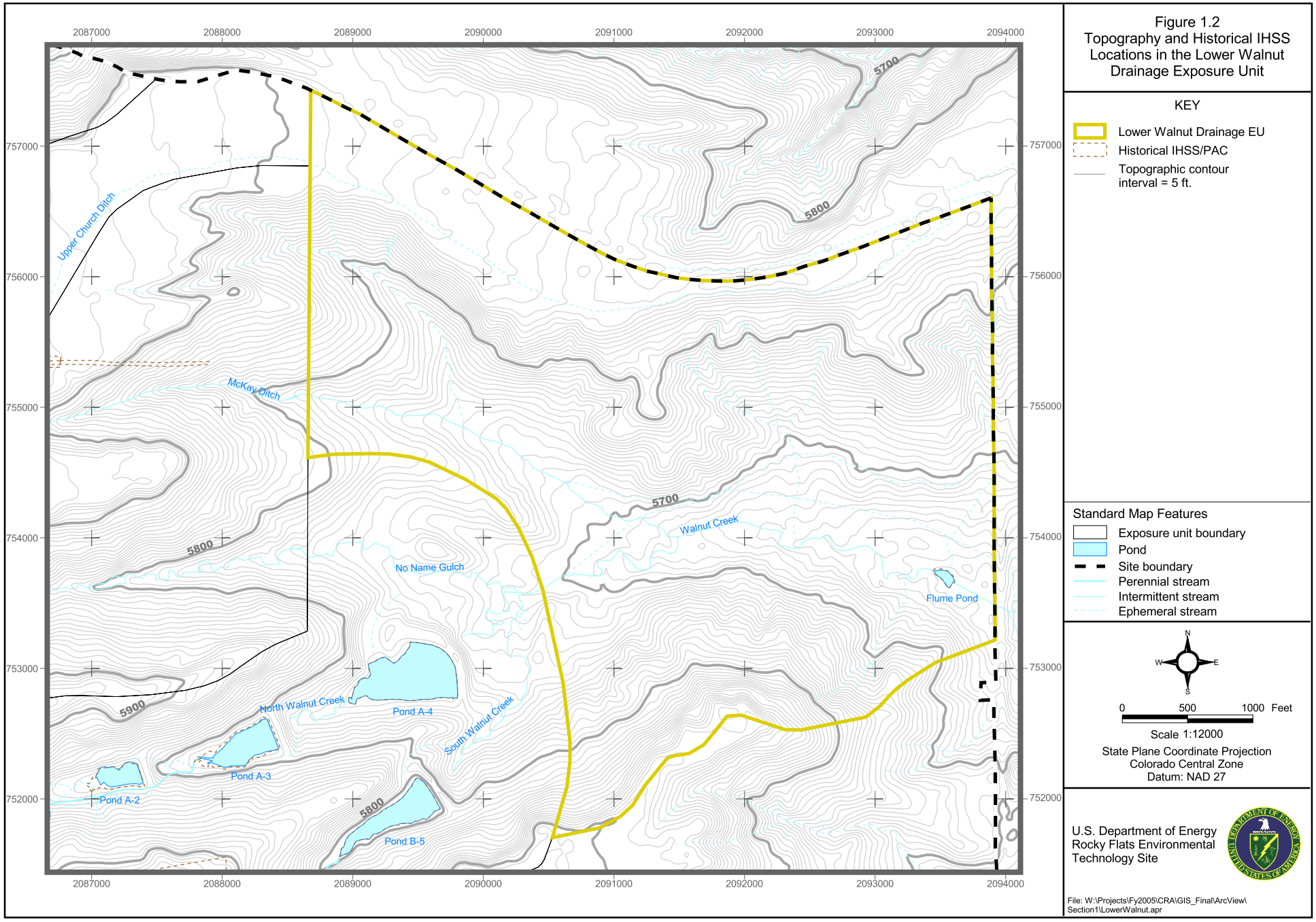


Figure 1.2
Topography and Historical IHSS Locations in the Lower Walnut Drainage Exposure Unit

KEY

- Lower Walnut Drainage EU
- Historical IHSS/PAC
- Topographic contour interval = 5 ft.

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W E
S

0 500 1000 Feet

Scale 1:12000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section1\LowerWalnut.apr

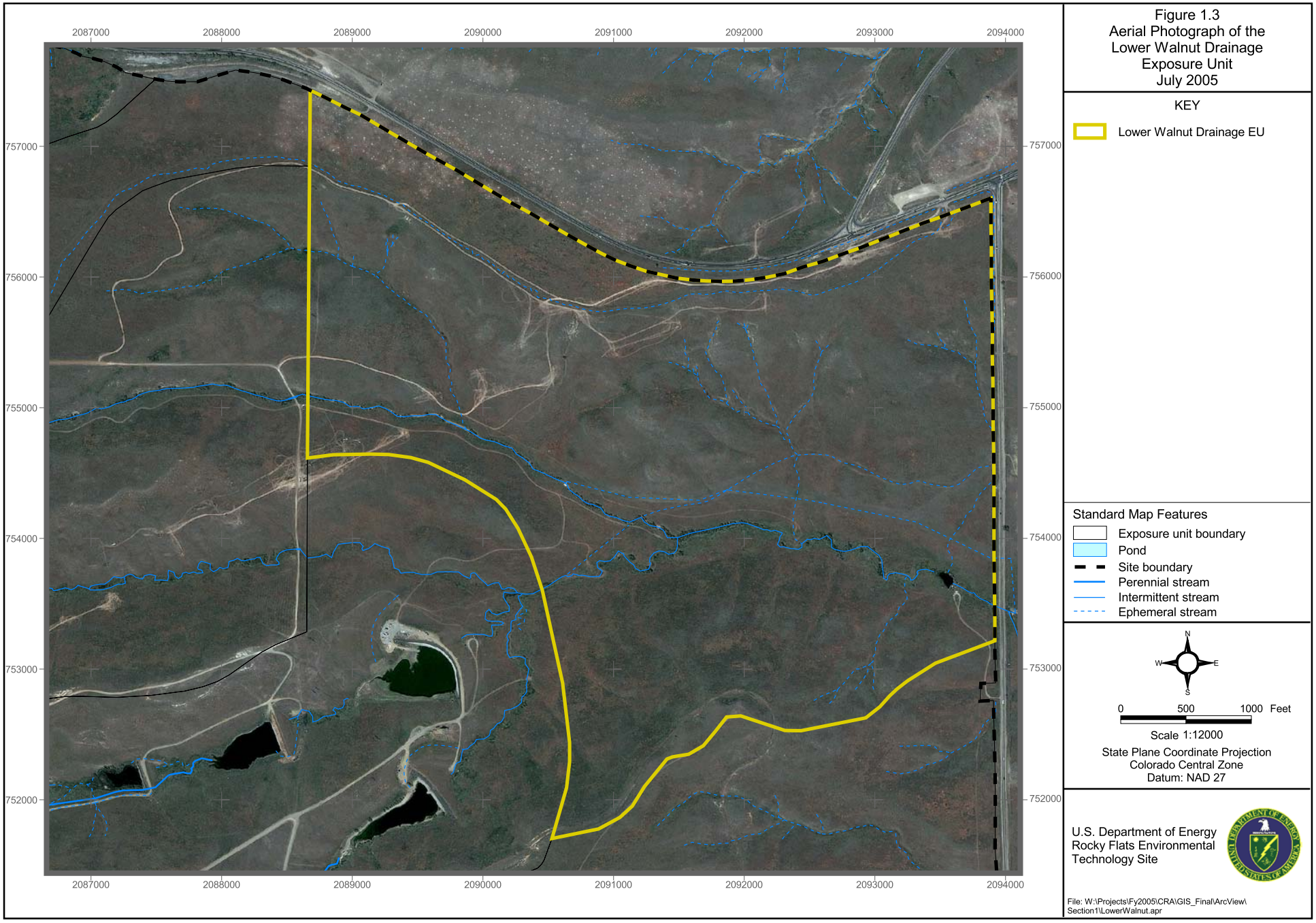


Figure 1.3
Aerial Photograph of the
Lower Walnut Drainage
Exposure Unit
July 2005

KEY

Lower Walnut Drainage EU

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W E
S

0 500 1000 Feet

Scale 1:12000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental
Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section1\LowerWalnut.apr

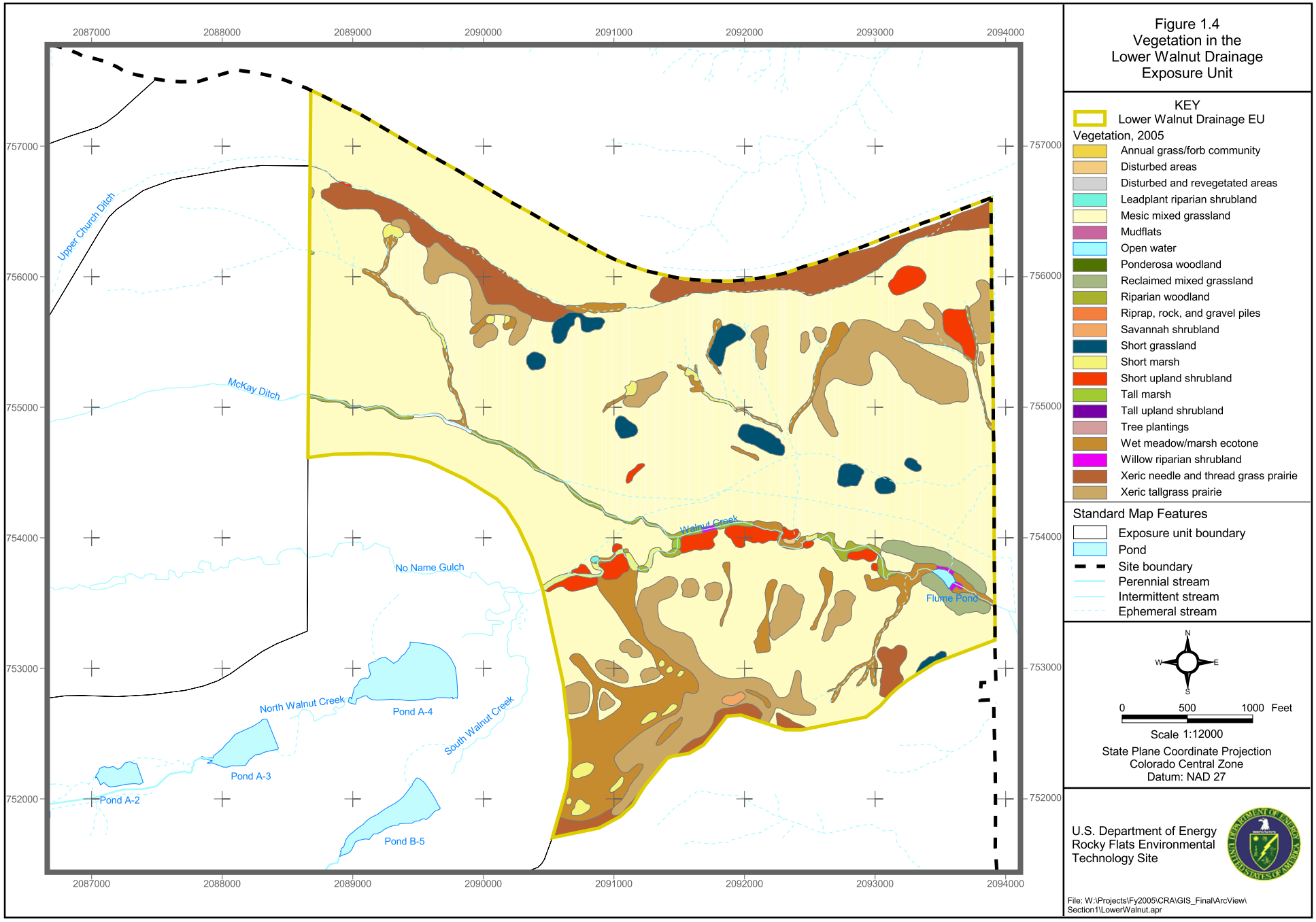


Figure 1.4
Vegetation in the
Lower Walnut Drainage
Exposure Unit

KEY

Lower Walnut Drainage EU

Vegetation, 2005

- Annual grass/forb community
- Disturbed areas
- Disturbed and revegetated areas
- Leadplant riparian shrubland
- Mesic mixed grassland
- Mudflats
- Open water
- Ponderosa woodland
- Reclaimed mixed grassland
- Riparian woodland
- Riprap, rock, and gravel piles
- Savannah shrubland
- Short grassland
- Short marsh
- Short upland shrubland
- Tall marsh
- Tall upland shrubland
- Tree plantings
- Wet meadow/marsh ecotone
- Willow riparian shrubland
- Xeric needle and thread grass prairie
- Xeric tallgrass prairie

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W
E
S

0 500 1000 Feet

Scale 1:12000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental
Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section1\LowerWalnut.apr

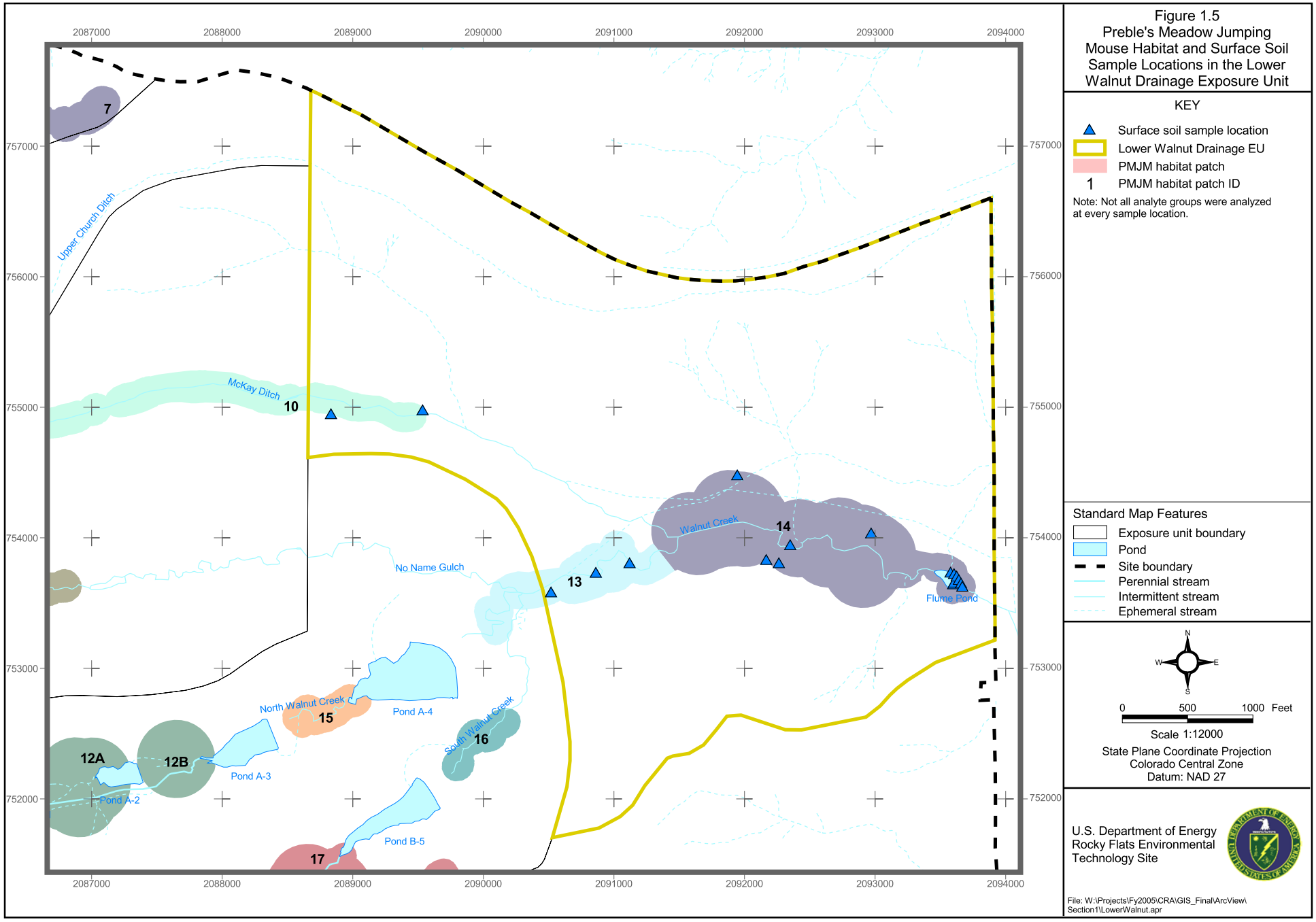


Figure 1.5
Preble's Meadow Jumping Mouse Habitat and Surface Soil Sample Locations in the Lower Walnut Drainage Exposure Unit

KEY

- Surface soil sample location
- Lower Walnut Drainage EU
- PMJM habitat patch
- 1 PMJM habitat patch ID

Note: Not all analyte groups were analyzed at every sample location.

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W
E
S

0 500 1000 Feet

Scale 1:12000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section1\LowerWalnut.apr

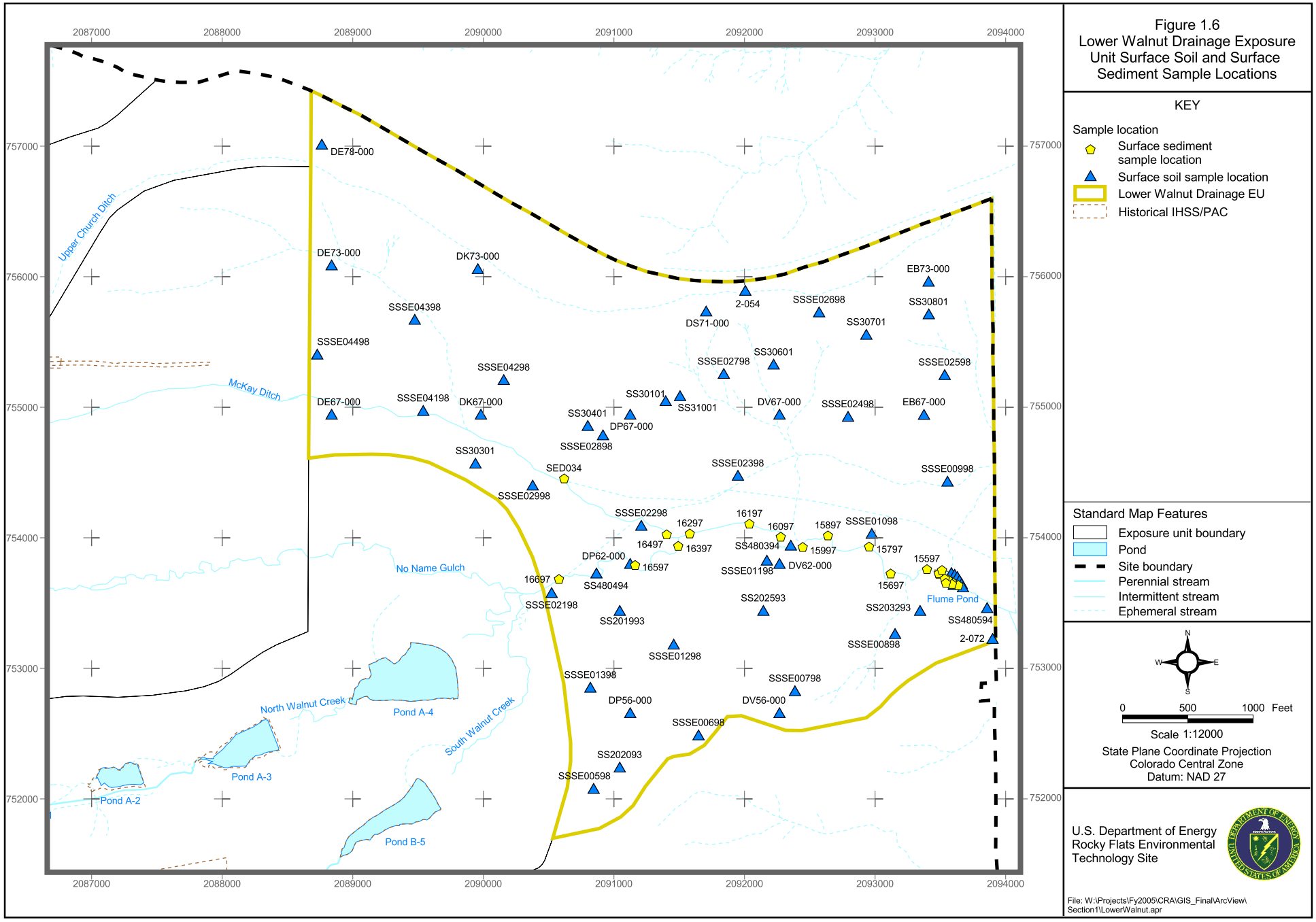


Figure 1.6
Lower Walnut Drainage Exposure Unit Surface Soil and Surface Sediment Sample Locations

KEY

Sample location

- Surface sediment sample location
- Surface soil sample location
- Lower Walnut Drainage EU
- Historical IHSS/PAC

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W
E
S

0 500 1000 Feet

Scale 1:12000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section1\LowerWalnut.apr

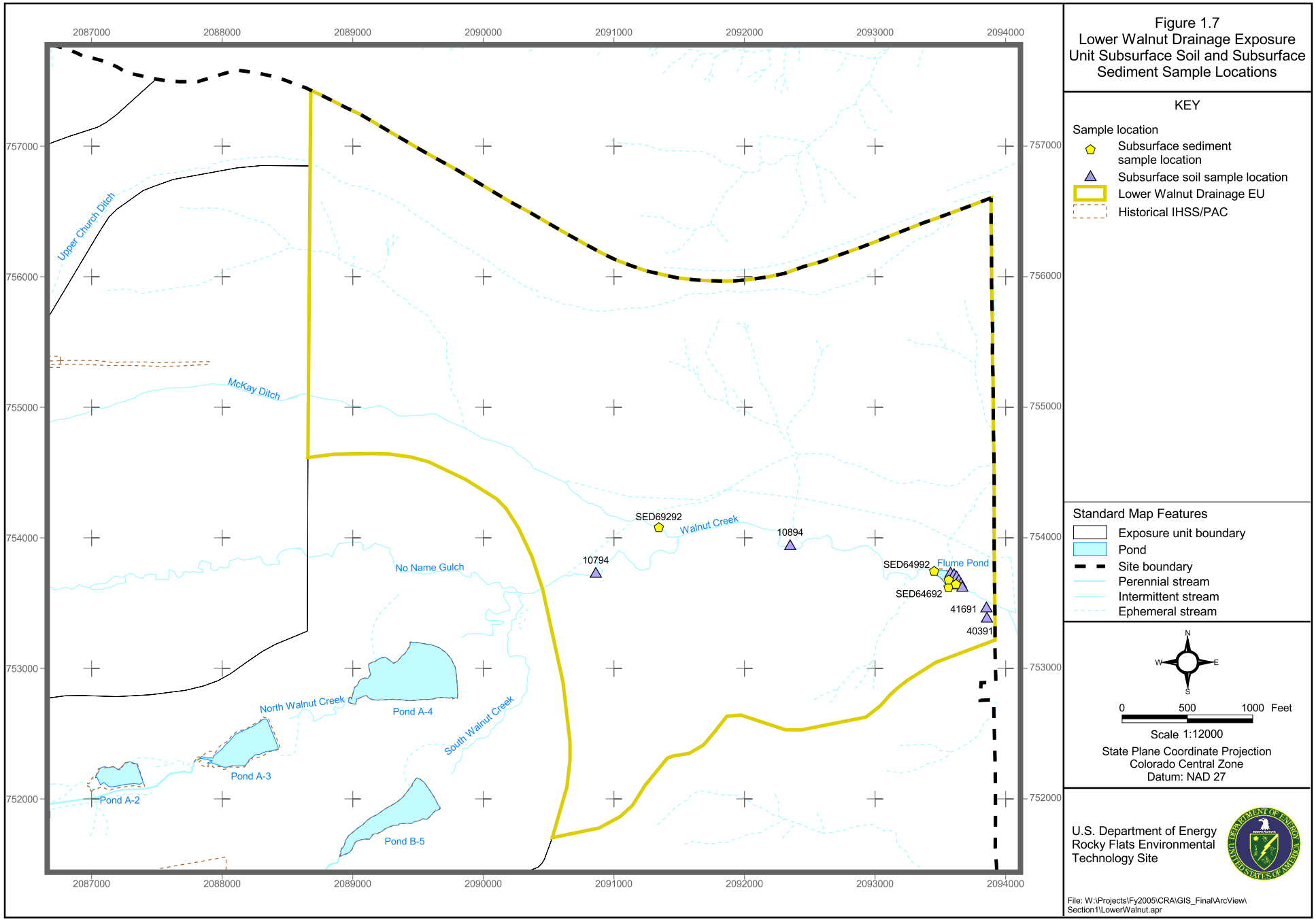


Figure 1.7
Lower Walnut Drainage Exposure Unit Subsurface Soil and Subsurface Sediment Sample Locations

KEY

Sample location
- Subsurface sediment sample location
- Subsurface soil sample location
- Lower Walnut Drainage EU
- Historical IHSS/PAC

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W
E
S

0 500 1000 Feet

Scale 1:12000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section1\LowerWalnut.apr

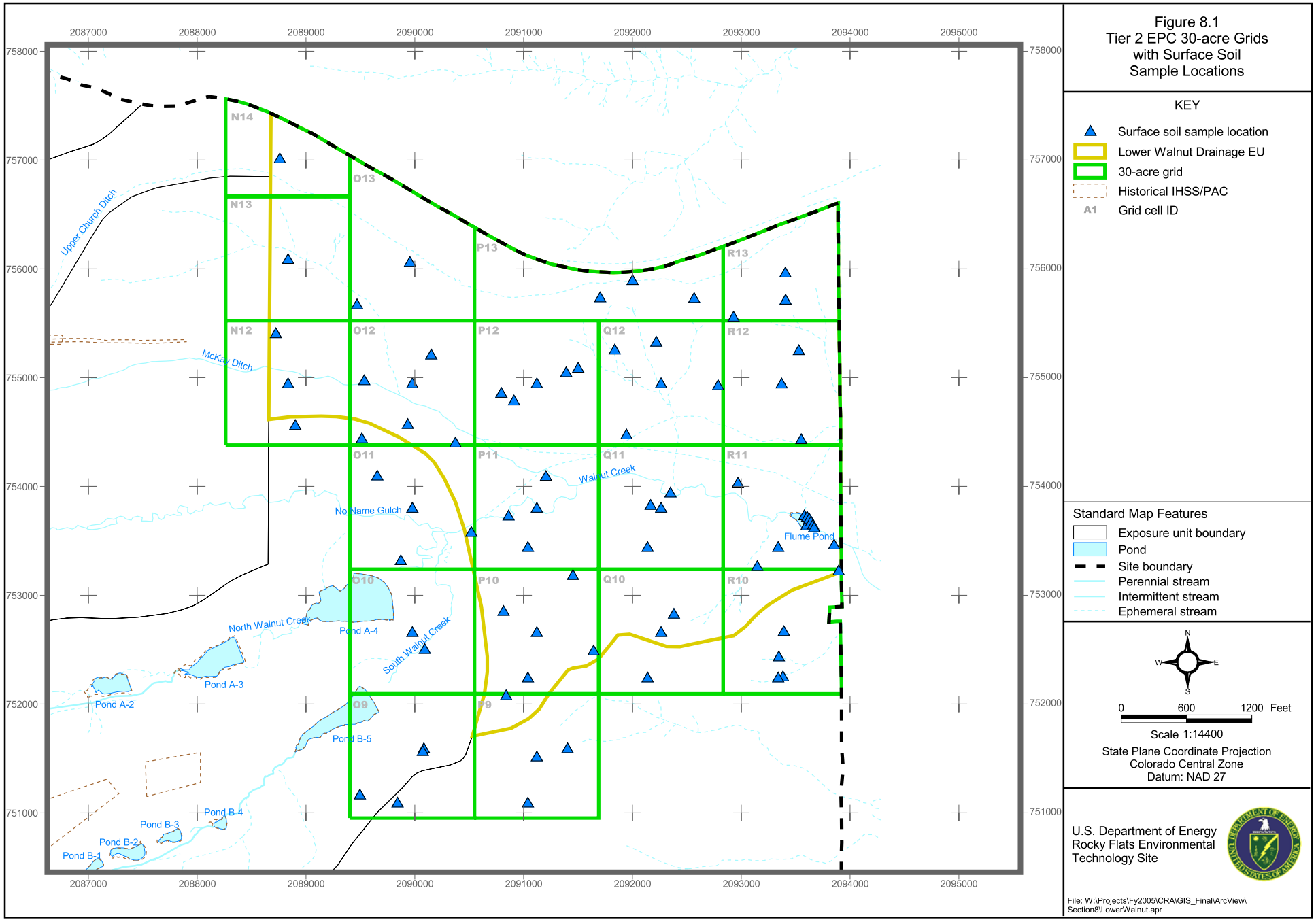


Figure 8.1
Tier 2 EPC 30-acre Grids with Surface Soil Sample Locations

KEY

- Surface soil sample location
- Lower Walnut Drainage EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W
E
S

0 600 1200 Feet

Scale 1:14400

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section8\LowerWalnut.apr

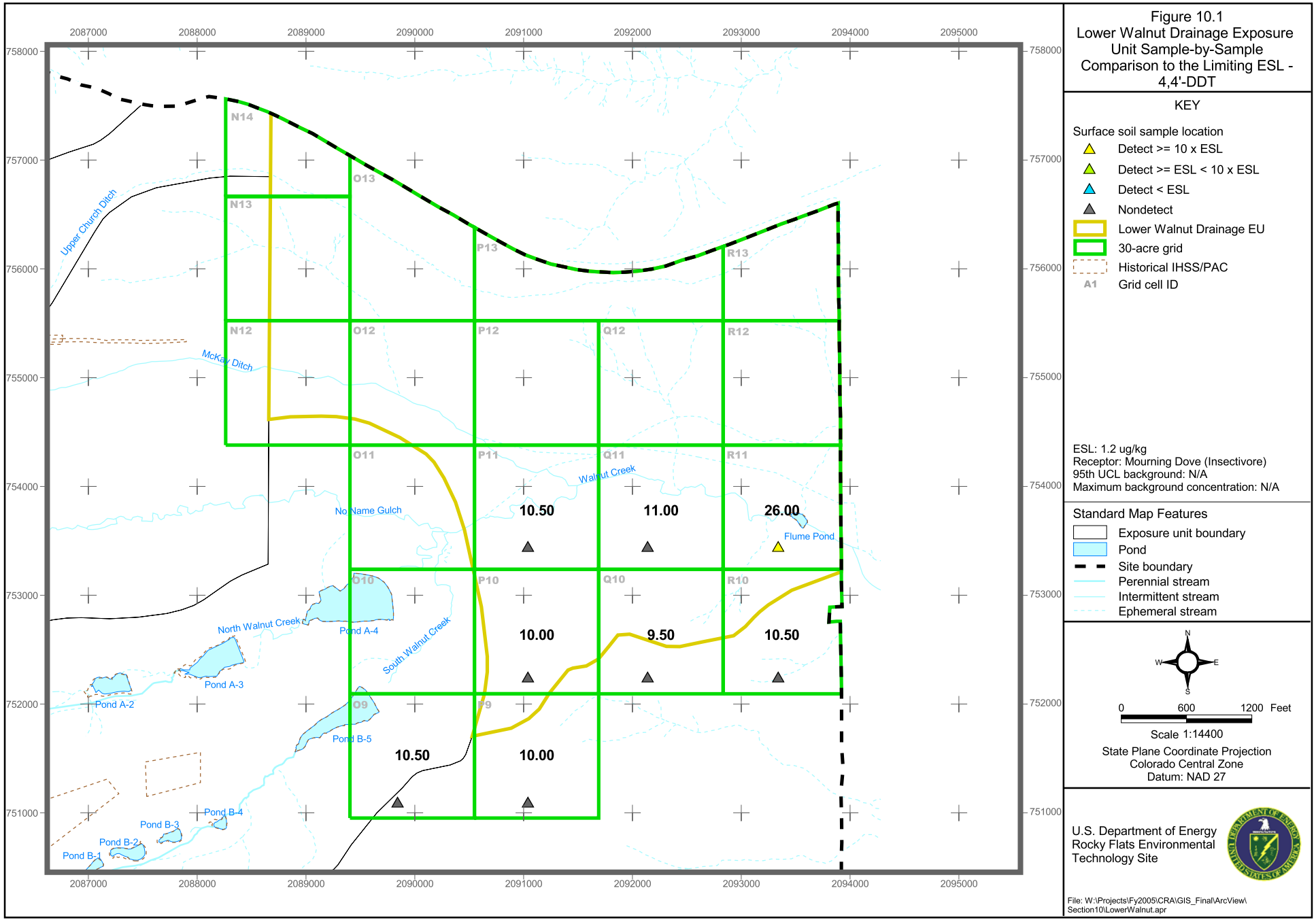


Figure 10.1
Lower Walnut Drainage Exposure Unit Sample-by-Sample Comparison to the Limiting ESL - 4,4'-DDT

KEY

Surface soil sample location
- Detect >= 10 x ESL
- Detect >= ESL < 10 x ESL
- Detect < ESL
- Nondetect
- Lower Walnut Drainage EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

ESL: 1.2 ug/kg
Receptor: Mourning Dove (Insectivore)
95th UCL background: N/A
Maximum background concentration: N/A

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W E
S

0 600 1200 Feet

Scale 1:14400

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section10\LowerWalnut.apr

COMPREHENSIVE RISK ASSESSMENT

LOWER WALNUT DRAINAGE EXPOSURE UNIT

VOLUME 8: ATTACHMENT 1

Detection Limit Screen

TABLE OF CONTENTS

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

µg/kg	micrograms per kilogram
µg/L	micrograms per liter
CD	compact disc
CRA	Comprehensive Risk Assessment
ESL	ecological screening level
IHSS	Individual Hazardous Substance Site
LWNEU	Lower Walnut Drainage Exposure Unit
mg/kg	milligrams per kilogram
N/A	not available or not applicable
NOAEL	no observed adverse effect level
PAC	Potential Area of Concern
pCi/g	picocuries per gram
PRG	preliminary remediation goal
TIC	tentatively identified compound
VOC	volatile organic compound
WRW	wildlife refuge worker

1.0 EVALUATION OF ANALYTE DETECTION LIMITS FOR THE LOWER WALNUT DRAINAGE EXPOSURE UNIT

For the Lower Walnut Drainage Exposure Unit (EU) (LWNEU), the detection limits for non-detected analytes as well as analytes detected in less than 5 percent of the samples are compared to human health preliminary remediation goals (PRGs) for the wildlife refuge worker (WRW) and the minimum ecological screening levels (ESLs). The comparisons are made in the tables to this attachment for potential contaminants of concern (PCOCs) in surface soil/surface sediment and subsurface soil/subsurface sediment, and ecological contaminants of interest (ECOIs) in surface soil and subsurface soil. The percent of the samples with detection limits that exceed the PRGs and ESLs are listed in these tables. When these detection limits exceed the respective PRGs and ESLs, this is a source of uncertainty in the risk assessment process, which is discussed herein.

Laboratory reported results for "U" qualified data (nondetects) are used to perform the detection limit screen rather than the detection limit identified in the detection limit field within the Soil Water Database (SWD). The basis for the detection limit is not always certain, i.e., Instrument Detection Limit (IDL), Method Detection Limit (MDL), Reporting Limit (RL), Sample Quantitation Limit (SQL), etc. Therefore, to be consistent in reporting, the "reported results" are presented in the tables to this attachment. Also, for statistical computations and risk estimations presented in the main text and tables to this volume, one-half the reported results are used as proxy values for nondetected data.

The term analyte as used in the following sections refers to analytes that are non-detected or detected in less than 5 percent of the samples. PRGs and ESLs do not exist for some of these analytes, which is also a source of uncertainty for the risk assessment. This uncertainty is discussed in Sections 6.2.1 and 10.3.2 of the main text of this volume.

1.1 Comparison of Reported Results to Preliminary Remediation Goals

1.1.1 Surface Soil/Surface Sediment

As shown in Table A1.1, there are only three analytes in surface soil/surface sediment where the reported results exceed the PRG: benzo(a)pyrene (85.7%), dibenz(a,h)anthracene (85.7%), and N-nitroso-di-n-propylamine (71.4%). In these three cases, the maximum reported results are within a factor of 2 of the PRGs. Therefore, because only three analytes have reported results that exceed the PRGs, and for these analytes, the reported results are the same order of magnitude as the PRGs, this represents only minimal uncertainty in the overall risk conclusions.

1.1.2 Subsurface Soil/Subsurface Sediment

All reported results are below the PRGs in subsurface soil/subsurface sediment (Table A1.2).

1.2 Comparison of Reported Results to Ecological Screening Levels

1.2.1 Surface Soil

As shown in Table A1.3, there are 16 analytes in surface soil where some percent of the reported results exceed the lowest ESL. For thallium and hexachlorobutadiene, more than

90 percent of the reported results are less than the lowest ESL. Consequently, for these analytes, there is minimal uncertainty in the overall risk estimates because of these higher reported results. Of the remaining 14 analytes, 100 percent of the reported results exceed the lowest ESL, and in some cases, the maximum reported results are more than an order of magnitude higher than the lowest ESL. This condition requires further analysis using professional judgment and ecological risk potential to determine the extent of uncertainty in the overall risk estimates, i.e., ecological risks may be underestimated because these analyte may have been included as ECOPCs had they been detected more frequently using lower detection limits (lower reported results).

Professional judgment indicates whether the analytes are likely to be ECOPCs in the LWNEU surface soil based on 1) a listing of the analytes (or classes of analytes) as constituents in wastes potentially released at historical Individual Hazardous Substance Sites (IHSSs) in the LWNEU (DOE 2005a), 2) the historical inventory for the chemical at RFETS (CDH 1991), and 3) a comparison of the maximum detected concentration and detection frequency in the EU and sitewide surface soil (see Table A1.4 for sitewide surface soil summary statistics). The comparison of the EU and sitewide maximum detected concentrations and detection frequencies in surface soil is performed to assess if the EU observations are much higher, which may potentially also indicate a source for the analyte within the EU. Using professional judgment, the analytes can be grouped into four categories that represent an ascending order of uncertainty. Category 1 is for analytes that were not listed as waste constituents for the EU historical IHSSs, and are not detected in the EU or sitewide surface soil. Category 2 is for analytes that may or may not be listed as waste constituents for the EU historical IHSSs, but nevertheless are not detected in the EU surface soil even though they were detected in other EU surface soil at RFETS at low maximum detected concentrations and low detection frequencies. Category 3 is for analytes that may or may not be listed as waste constituents for the EU historical IHSSs, and are detected in the EU (and therefore sitewide) surface soil, and the maximum detected concentrations in the EU surface soil are approximately the same order of magnitude as the ESL, and the detection frequencies are low. For these first three categories, the uncertainty with regard to the risk estimates because of the higher detection limits is considered small. Category 4 is for analytes that are detected in the EU (and therefore sitewide) surface soil at maximum concentrations that substantially exceed the ESLs and at detection frequencies generally higher than for Category 3, i.e., these analytes have the highest likelihood of being ECOPCs had they been detected more frequently using lower detection limits (lower reported results), and therefore, there is some uncertainty with regard to the risk estimates because of the higher detection limits.

The assessment of the ecological risk potential compares the maximum reported result to a Lowest Observed Adverse Effect Level (LOAEL)-based soil concentration. ESLs are based on No Observed Adverse Effect Levels (NOAELs) (DOE 2005b). The LOAEL-based soil concentration is estimated by multiplying the lowest ESL by the LOAEL/NOAEL ratio for the mammal or the bird depending on whether a mammal or bird is the most sensitive terrestrial vertebrate receptor for the chemical (see Appendix B, Table B-2 of the Final CRA Work Plan and Methodology, Revision 1 (DOE 2005b) for the Lowest Bounded LOAELs and Final NOAELs for mammals and birds). A maximum reported result/LOAEL-based soil concentration ratio greater than one indicates a

potential for an adverse ecological effect if the analyte was detected at the highest reported result.

As shown in Table A1.5, all of the 14 analytes assessed using professional judgment are in categories 1 and 2, and thus are not likely to be present in the LWNEU surface soil based on professional judgment, which minimizes the uncertainty in the overall risk estimates because of their higher reported results. Comparing the maximum reported results to the LOAEL-based soil concentrations indicates more than half of the above noted analytes would also not present a potential for adverse ecological effects if they were detected at the maximum reported results.

In conclusion, analytes in surface soil that have reported results that exceed the lowest ESLs contribute only minimal uncertainty to the overall risk estimates because either only a small fraction of the reported results are greater than the lowest ESL, or professional judgment indicates they are not likely to be present in LWNEU surface soil. Although some of the analytes would present a potential for adverse ecological effects if they were detected at their maximum reported results, because they are not expected to be present in LWNEU surface soil, uncertainty in the overall risk estimates is low.

1.2.2 Subsurface Soil

All reported results are below the ESLs in subsurface soil (Table A1.6).

2.0 REFERENCES

CDH, 1991. Colorado Department of Health Project Task 1 Report (Revised 1), Identification of Chemicals and Radionuclides Used at Rocky Flats. Prepared by ChemRisk. March.

DOE, 2005a, 2005 Annual Update to the Historical Release Report, Rocky Flats Environmental Technology Site, October.

DOE, 2005b. Final Comprehensive Risk Assessment Work Plan and Methodology, Revision 1, Rocky Flats Environmental Technology Site, Golden, Colorado. Revision 1. September.

TABLES

Table A1.1
Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil/Surface Sediment in the LWNEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	PRG	Number of Nondetected Results > PRG	Percent Nondetected Results > PRG	Analyte Detected?
Inorganic (mg/kg)								
Cesium	0.830	-	140	7	N/A	0	0	No
Chromium VI	1.10	-	1.10	1	28.4	0	0	No
Uranium	1.60	-	18	17	333	0	0	No
Organic (ug/kg)								
1,1,1,2-Tetrachloroethane	5.80	-	6.40	8	91,018	0	0	No
1,1,1-Trichloroethane	5	-	10	11	9.18E+06	0	0	No
1,1,2,2-Tetrachloroethane	5	-	10	11	10,483	0	0	No
1,1,2-Trichloro-1,2,2-trifluoroethane	5.80	-	6.40	8	2.38E+09	0	0	No
1,1,2-Trichloroethane	5	-	10	11	28,022	0	0	No
1,1-Dichloroethane	5	-	10	11	2.72E+06	0	0	No
1,1-Dichloroethene	5	-	10	11	17,366	0	0	No
1,1-Dichloropropene	5.80	-	6.40	8	N/A	0	0	No
1,2,3-Trichlorobenzene	5.80	-	6.40	8	N/A	0	0	No
1,2,3-Trichloropropane	5.80	-	6.40	8	2,079	0	0	No
1,2,4-Trichlorobenzene	5.80	-	600	15	151,360	0	0	No
1,2,4-Trimethylbenzene	5.80	-	6.40	8	132,620	0	0	No
1,2-Dibromo-3-chloropropane	5.80	-	6.40	8	2,968	0	0	No
1,2-Dibromoethane	5.80	-	6.40	8	35.1	0	0	No
1,2-Dichlorobenzene	5.80	-	600	15	2.89E+06	0	0	No
1,2-Dichloroethane	5	-	10	11	13,270	0	0	No
1,2-Dichloroethene	5	-	10	3	999,783	0	0	No
1,2-Dichloropropane	5	-	10	11	38,427	0	0	No
1,3,5-Trimethylbenzene	5.80	-	6.40	8	114,340	0	0	No
1,3-Dichlorobenzene	5.80	-	600	15	3.33E+06	0	0	No
1,3-Dichloropropane	5.80	-	6.40	8	N/A	0	0	No
2,2-Dichloropropane	5.80	-	6.40	8	N/A	0	0	No
2,4,5-Trichlorophenol	1,700	-	2,900	7	8.01E+06	0	0	No
2,4,6-Trichlorophenol	340	-	600	7	272,055	0	0	No
2,4-Dichlorophenol	340	-	600	7	240,431	0	0	No
2,4-Dimethylphenol	340	-	600	7	1.60E+06	0	0	No
2,4-Dinitrophenol	1,700	-	2,900	7	160,287	0	0	No
2,4-Dinitrotoluene	340	-	600	7	160,287	0	0	No
2,6-Dinitrotoluene	340	-	600	7	80,144	0	0	No
2-Chloronaphthalene	340	-	600	7	6.41E+06	0	0	No
2-Chlorophenol	340	-	600	7	555,435	0	0	No
2-Chlorotoluene	5.80	-	6.40	8	2.22E+06	0	0	No
2-Hexanone	10	-	64.2	11	N/A	0	0	No
2-Methylnaphthalene	340	-	600	7	320,574	0	0	No
2-Methylphenol	340	-	600	7	4.01E+06	0	0	No
2-Nitroaniline	1,700	-	2,900	7	192,137	0	0	No
2-Nitrophenol	340	-	600	7	N/A	0	0	No
3,3'-Dichlorobenzidine	680	-	1,200	7	6,667	0	0	No
3-Nitroaniline	1,700	-	2,900	6	N/A	0	0	No
4,4'-DDD	16	-	29	7	15,528	0	0	No
4,4'-DDE	16	-	70	7	10,961	0	0	No
4,6-Dinitro-2-methylphenol	1,700	-	2,900	7	8,014	0	0	No
4-Bromophenyl-phenylether	340	-	600	7	N/A	0	0	No
4-Chloro-3-methylphenol	340	-	600	7	N/A	0	0	No
4-Chloroaniline	340	-	600	7	320,574	0	0	No
4-Chlorophenyl-phenyl ether	340	-	600	7	N/A	0	0	No
4-Chlorotoluene	5.80	-	6.40	8	N/A	0	0	No
4-Isopropyltoluene	5.80	-	6.40	8	N/A	0	0	No
4-Methyl-2-pentanone	10	-	64.2	11	8.32E+07	0	0	No
4-Methylphenol	340	-	600	7	400,718	0	0	No
4-Nitroaniline	1,700	-	2,900	7	207,917	0	0	No
4-Nitrophenol	1,700	-	2,900	7	641,148	0	0	No
Acenaphthene	340	-	600	7	4.44E+06	0	0	No
Acenaphthylene	340	-	600	7	N/A	0	0	No
Aldrin	8.10	-	14	7	176	0	0	No
alpha-BHC	8.10	-	14	7	570	0	0	No

Table A1.1
Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil/Surface Sediment in the LWNEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	PRG	Number of Nondetected Results > PRG	Percent Nondetected Results > PRG	Analyte Detected?
alpha-Chlordane	81	-	140	7	10,261	0	0	No
Anthracene	340	-	600	7	2.22E+07	0	0	No
Benzene	5	-	10	11	23,563	0	0	No
Benzo(a)anthracene	340	-	600	7	3,793	0	0	No
Benzo(a)pyrene	340	-	600	7	379	6	85.7142868	No
Benzo(b)fluoranthene	340	-	600	7	3,793	0	0	No
Benzo(g,h,i)perylene	340	-	600	7	N/A	0	0	No
Benzo(k)fluoranthene	340	-	600	7	37,927	0	0	No
Benzyl Alcohol	340	-	600	7	2.40E+07	0	0	No
beta-BHC	8.10	-	14	7	1,995	0	0	No
beta-Chlordane	100	-	140	6	10,261	0	0	No
bis(2-Chloroethoxy) methane	340	-	600	7	N/A	0	0	No
bis(2-Chloroethyl) ether	340	-	600	7	3,767	0	0	No
bis(2-Chloroisopropyl) ether	340	-	600	7	59,301	0	0	No
Bromobenzene	5.80	-	6.40	8	N/A	0	0	No
Bromochloromethane	5.80	-	6.40	8	N/A	0	0	No
Bromodichloromethane	5	-	10	11	67,070	0	0	No
Bromoform	5	-	10	11	419,858	0	0	No
Bromomethane	5.80	-	21	11	20,959	0	0	No
Butylbenzylphthalate	340	-	600	7	1.60E+07	0	0	No
Carbon Disulfide	5	-	10	11	1.64E+06	0	0	No
Carbon Tetrachloride	5	-	10	11	8,446	0	0	No
Chlorobenzene	5	-	10	11	666,523	0	0	No
Chloroethane	5.80	-	21	11	1.43E+06	0	0	No
Chloroform	5	-	10	11	7,850	0	0	No
Chloromethane	5.80	-	21	11	115,077	0	0	No
Chrysene	340	-	600	7	379,269	0	0	No
cis-1,2-Dichloroethene	5.80	-	6.40	8	1.11E+06	0	0	No
cis-1,3-Dichloropropene	5	-	10	11	19,432	0	0	No
Dibenz(a,h)anthracene	340	-	600	7	379	6	85.7142868	No
Dibenzofuran	340	-	600	7	222,174	0	0	No
Dibromochloromethane	5	-	10	11	49,504	0	0	No
Dibromomethane	5.80	-	6.40	8	N/A	0	0	No
Dichlorodifluoromethane	5.80	-	6.40	8	229,820	0	0	No
Dieldrin	16	-	29	7	187	0	0	No
Diethylphthalate	340	-	600	7	6.41E+07	0	0	No
Dimethylphthalate	340	-	600	7	8.01E+08	0	0	No
Di-n-octylphthalate	340	-	600	7	3.21E+06	0	0	No
Endosulfan I	8.10	-	14	7	480,861	0	0	No
Endosulfan II	16	-	29	7	480,861	0	0	No
Endosulfan sulfate	16	-	29	7	480,861	0	0	No
Endrin	16	-	29	7	24,043	0	0	No
Endrin ketone	16	-	29	7	33,326	0	0	No
Ethylbenzene	5	-	10	11	5.39E+06	0	0	No
Fluoranthene	340	-	600	7	2.96E+06	0	0	No
Fluorene	340	-	600	7	3.21E+06	0	0	No
gamma-BHC (Lindane)	8.10	-	14	7	2,771	0	0	No
gamma-Chlordane	81	-	81	1	10,261	0	0	No
Heptachlor	8.10	-	14	7	665	0	0	No
Heptachlor epoxide	8.10	-	14	7	329	0	0	No
Hexachlorobenzene	340	-	600	7	1,870	0	0	No
Hexachlorobutadiene	5.80	-	600	15	22,217	0	0	No
Hexachlorocyclopentadiene	340	-	600	7	380,452	0	0	No
Hexachloroethane	340	-	600	7	111,087	0	0	No
Indeno(1,2,3-cd)pyrene	340	-	600	7	3,793	0	0	No
Isophorone	340	-	600	7	3.16E+06	0	0	No
Isopropylbenzene	5.80	-	6.40	8	32,680	0	0	No
Methoxychlor	81	-	140	7	400,718	0	0	No
Naphthalene	5.80	-	600	15	1.40E+06	0	0	No
n-Butylbenzene	5.80	-	6.40	8	N/A	0	0	No
Nitrobenzene	340	-	600	7	43,246	0	0	No

Table A1.1
Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil/Surface Sediment in the LWNEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	PRG	Number of Nondetected Results > PRG	Percent Nondetected Results > PRG	Analyte Detected?
N-Nitroso-di-n-propylamine	340	-	600	7	429	5	71.42857361	No
N-nitrosodiphenylamine	340	-	600	7	612,250	0	0	No
n-Propylbenzene	5.80	-	6.40	8	N/A	0	0	No
PCB-1016	81	-	140	7	1,349	0	0	No
PCB-1221	81	-	140	7	1,349	0	0	No
PCB-1232	81	-	140	7	1,349	0	0	No
PCB-1242	81	-	140	7	1,349	0	0	No
PCB-1248	81	-	140	7	1,349	0	0	No
PCB-1254	160	-	290	7	1,349	0	0	No
PCB-1260	160	-	290	7	1,349	0	0	No
Pentachlorophenol	1,700	-	2,900	7	17,633	0	0	No
Phenanthrene	340	-	600	7	N/A	0	0	No
Pyrene	340	-	600	7	2.22E+06	0	0	No
sec-Butylbenzene	5.80	-	6.40	8	N/A	0	0	No
Styrene	5	-	10	11	1.38E+07	0	0	No
tert-Butylbenzene	5.80	-	6.40	8	N/A	0	0	No
Toxaphene	160	-	290	7	2,720	0	0	No
trans-1,2-Dichloroethene	5.80	-	6.40	8	287,340	0	0	No
trans-1,3-Dichloropropene	5	-	10	11	20,820	0	0	No
Trichloroethene	5	-	10	11	1,770	0	0	No
Trichlorofluoromethane	5.80	-	6.40	8	1.51E+06	0	0	No
Vinyl acetate	10	-	21	3	2.65E+06	0	0	No
Vinyl Chloride	5.80	-	21	11	2,169	0	0	No
Xylene	5	-	10	11	1.06E+06	0	0	No

N/A = Not available.

Table A1.2
Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Suburface Soil/Subsurface Sediment in the LWNEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	PRG	Number of Nondetected Results > PRG	Percent Nondetected Results > PRG	Analyte Detected?
Inorganic (mg/kg)								
Antimony	0.510	-	20	18	511	0	0	No
Cadmium	0.0380	-	1.50	20	1,051	0	0	No
Organic (ug/kg)								
1,1,1,2-Tetrachloroethane	5.50	-	6.20	8	1.05E+06	0	0	No
1,1,1-Trichloroethane	5	-	9	21	1.06E+08	0	0	No
1,1,2,2-Tetrachloroethane	5	-	9	21	120,551	0	0	No
1,1,2-Trichloro-1,2,2-trifluoroethane	5.50	-	6.20	8	2.74E+10	0	0	No
1,1,2-Trichloroethane	5	-	9	21	322,253	0	0	No
1,1-Dichloroethane	5	-	9	21	3.12E+07	0	0	No
1,1-Dichloroethene	5	-	9	21	199,706	0	0	No
1,1-Dichloropropene	5.50	-	6.20	8	N/A	0	0	No
1,2,3-Trichlorobenzene	5.50	-	6.20	8	N/A	0	0	No
1,2,3-Trichloropropane	5.50	-	6.20	8	23,910	0	0	No
1,2,4-Trichlorobenzene	5.50	-	530	13	1.74E+06	0	0	No
1,2,4-Trimethylbenzene	5.50	-	6.20	8	1.53E+06	0	0	No
1,2-Dibromo-3-chloropropane	5.50	-	6.20	8	34,137	0	0	No
1,2-Dibromoethane	5.50	-	6.20	8	403	0	0	No
1,2-Dichlorobenzene	5.50	-	530	13	3.32E+07	0	0	No
1,2-Dichloroethane	5	-	9	21	152,603	0	0	No
1,2-Dichloroethene	5	-	9	13	1.15E+07	0	0	No
1,2-Dichloropropane	5	-	9	21	441,907	0	0	No
1,3,5-Trimethylbenzene	5.50	-	6.20	8	1.31E+06	0	0	No
1,3-Dichlorobenzene	5.50	-	530	13	3.83E+07	0	0	No
1,3-Dichloropropane	5.50	-	6.20	8	N/A	0	0	No
2,2-Dichloropropane	5.50	-	6.20	8	N/A	0	0	No
2,4,5-Trichlorophenol	2,000	-	2,600	5	9.22E+07	0	0	No
2,4,6-Trichlorophenol	400	-	530	5	3.13E+06	0	0	No
2,4-Dichlorophenol	400	-	530	5	2.76E+06	0	0	No
2,4-Dimethylphenol	400	-	530	5	1.84E+07	0	0	No
2,4-Dinitrophenol	2,000	-	2,600	4	1.84E+06	0	0	No
2,4-Dinitrotoluene	400	-	530	5	1.84E+06	0	0	No
2,6-Dinitrotoluene	400	-	530	5	921,651	0	0	No
2-Chloronaphthalene	400	-	530	5	7.37E+07	0	0	No
2-Chlorophenol	400	-	530	5	6.39E+06	0	0	No
2-Chlorotoluene	5.50	-	6.20	8	2.56E+07	0	0	No
2-Hexanone	11	-	62.1	19	N/A	0	0	No
2-Methylnaphthalene	400	-	530	5	3.69E+06	0	0	No
2-Methylphenol	400	-	530	5	4.61E+07	0	0	No
2-Nitroaniline	2,000	-	2,600	5	2.21E+06	0	0	No
2-Nitrophenol	400	-	530	5	N/A	0	0	No
3,3'-Dichlorobenzidine	810	-	1,100	5	76,667	0	0	No
3-Nitroaniline	2,000	-	2,600	5	N/A	0	0	No
4,4'-DDD	20	-	26	5	178,570	0	0	No
4,4'-DDE	20	-	26	5	126,049	0	0	No
4,4'-DDT	20	-	26	5	125,658	0	0	No
4,6-Dinitro-2-methylphenol	2,000	-	2,600	5	92,165	0	0	No
4-Bromophenyl-phenylether	400	-	530	5	N/A	0	0	No
4-Chloro-3-methylphenol	400	-	530	5	N/A	0	0	No
4-Chloroaniline	400	-	530	5	3.69E+06	0	0	No
4-Chlorophenyl-phenyl ether	400	-	530	5	N/A	0	0	No
4-Chlorotoluene	5.50	-	6.20	8	N/A	0	0	No
4-Isopropyltoluene	5.50	-	6.20	8	N/A	0	0	No
4-Methyl-2-pentanone	11	-	62.1	19	9.57E+08	0	0	No
4-Methylphenol	400	-	530	5	4.61E+06	0	0	No
4-Nitroaniline	2,000	-	2,600	5	2.39E+06	0	0	No
4-Nitrophenol	2,000	-	2,600	5	7.37E+06	0	0	No
Acenaphthene	400	-	530	5	5.10E+07	0	0	No
Acenaphthylene	400	-	530	5	N/A	0	0	No
Aldrin	9.80	-	13	5	2,024	0	0	No
alpha-BHC	9.80	-	13	5	6,555	0	0	No

Table A1.2
Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Suburface Soil/Subsurface Sediment in the LWNEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	PRG	Number of Nondetected Results > PRG	Percent Nondetected Results > PRG	Analyte Detected?
alpha-Chlordane	98	-	130	5	117,997	0	0	No
Anthracene	400	-	530	5	2.55E+08	0	0	No
Benzene	5	-	9	21	270,977	0	0	No
Benzo(a)anthracene	400	-	530	5	43,616	0	0	No
Benzo(a)pyrene	400	-	530	5	4,357	0	0	No
Benzo(b)fluoranthene	400	-	530	5	43,616	0	0	No
Benzo(g,h,i)perylene	400	-	530	5	N/A	0	0	No
Benzo(k)fluoranthene	400	-	530	5	436,159	0	0	No
beta-BHC	9.80	-	13	5	22,942	0	0	No
beta-Chlordane	98	-	130	5	117,997	0	0	No
bis(2-Chloroethoxy) methane	400	-	530	5	N/A	0	0	No
bis(2-Chloroethyl) ether	400	-	530	5	43,315	0	0	No
bis(2-Chloroisopropyl) ether	400	-	530	5	681,967	0	0	No
Bromobenzene	5.50	-	6.20	8	N/A	0	0	No
Bromochloromethane	5.50	-	6.20	8	N/A	0	0	No
Bromodichloromethane	5	-	9	21	771,304	0	0	No
Bromoform	5	-	9	21	4.83E+06	0	0	No
Bromomethane	5.50	-	18	20	241,033	0	0	No
Butylbenzylphthalate	400	-	530	5	1.84E+08	0	0	No
Carbon Disulfide	5	-	9	21	1.88E+07	0	0	No
Carbon Tetrachloride	5	-	9	21	97,124	0	0	No
Chlorobenzene	5	-	9	21	7.67E+06	0	0	No
Chloroethane	5.50	-	18	20	1.65E+07	0	0	No
Chloroform	5	-	9	21	90,270	0	0	No
Chloromethane	5.50	-	18	21	1.32E+06	0	0	No
Chrysene	400	-	530	5	4.36E+06	0	0	No
cis-1,2-Dichloroethene	5.50	-	6.20	8	1.28E+07	0	0	No
cis-1,3-Dichloropropene	5	-	9	21	223,462	0	0	No
delta-BHC	9.80	-	13	5	6,555	0	0	No
Dibenz(a,h)anthracene	400	-	530	5	4,362	0	0	No
Dibenzofuran	400	-	530	5	2.56E+06	0	0	No
Dibromochloromethane	5	-	9	21	569,296	0	0	No
Dibromomethane	5.50	-	6.20	8	N/A	0	0	No
Dichlorodifluoromethane	5.50	-	6.20	8	2.64E+06	0	0	No
Dieldrin	20	-	26	5	2,151	0	0	No
Diethylphthalate	400	-	530	5	7.37E+08	0	0	No
Dimethylphthalate	400	-	530	5	9.22E+09	0	0	No
Di-n-octylphthalate	400	-	530	5	3.69E+07	0	0	No
Endosulfan I	9.80	-	13	5	5.53E+06	0	0	No
Endosulfan II	20	-	26	5	5.53E+06	0	0	No
Endosulfan sulfate	20	-	26	5	5.53E+06	0	0	No
Endrin	20	-	26	5	276,495	0	0	No
Endrin ketone	20	-	26	5	383,250	0	0	No
Ethylbenzene	5	-	9	21	6.19E+07	0	0	No
Fluoranthene	400	-	530	5	3.40E+07	0	0	No
Fluorene	400	-	530	5	3.69E+07	0	0	No
gamma-BHC (Lindane)	9.80	-	13	5	31,864	0	0	No
Heptachlor	9.80	-	13	5	7,647	0	0	No
Heptachlor epoxide	9.80	-	13	5	3,782	0	0	No
Hexachlorobenzene	400	-	530	5	21,508	0	0	No
Hexachlorobutadiene	5.50	-	530	13	255,500	0	0	No
Hexachlorocyclopentadiene	400	-	530	5	4.38E+06	0	0	No
Hexachloroethane	400	-	530	5	1.28E+06	0	0	No
Indeno(1,2,3-cd)pyrene	400	-	530	5	43,616	0	0	No
Isophorone	400	-	530	5	3.63E+07	0	0	No
Isopropylbenzene	5.50	-	6.20	8	375,823	0	0	No
Methoxychlor	98	-	130	5	4.61E+06	0	0	No
Naphthalene	5.50	-	530	13	1.61E+07	0	0	No
n-Butylbenzene	5.50	-	6.20	8	N/A	0	0	No
Nitrobenzene	400	-	530	5	497,333	0	0	No
N-Nitroso-di-n-propylamine	400	-	530	5	4,929	0	0	No

Table A1.2
Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Suburface Soil/Subsurface Sediment in the LWNEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	PRG	Number of Nondetected Results > PRG	Percent Nondetected Results > PRG	Analyte Detected?
N-nitrosodiphenylamine	400	-	530	5	7.04E+06	0	0	No
n-Propylbenzene	5.50	-	6.20	8	N/A	0	0	No
PCB-1016	98	-	130	5	15,514	0	0	No
PCB-1221	98	-	130	5	15,514	0	0	No
PCB-1232	98	-	130	5	15,514	0	0	No
PCB-1242	98	-	130	5	15,514	0	0	No
PCB-1248	98	-	130	5	15,514	0	0	No
PCB-1254	200	-	260	5	15,514	0	0	No
PCB-1260	200	-	260	5	15,514	0	0	No
Pentachlorophenol	2,000	-	2,600	5	202,777	0	0	No
Phenanthrene	400	-	530	5	N/A	0	0	No
Phenol	400	-	530	5	2.76E+08	0	0	No
Pyrene	400	-	530	5	2.55E+07	0	0	No
sec-Butylbenzene	5.50	-	6.20	8	N/A	0	0	No
Styrene	5	-	9	21	1.59E+08	0	0	No
tert-Butylbenzene	5.50	-	6.20	8	N/A	0	0	No
Tetrachloroethene	5	-	9	21	77,111	0	0	No
Toxaphene	200	-	260	5	31,284	0	0	No
trans-1,2-Dichloroethene	5.50	-	6.20	8	3.30E+06	0	0	No
trans-1,3-Dichloropropene	5	-	9	21	239,434	0	0	No
Trichloroethene	5	-	9	21	20,354	0	0	No
Trichlorofluoromethane	5.50	-	6.20	8	1.74E+07	0	0	No
Vinyl acetate	11	-	18	11	3.04E+07	0	0	No
Vinyl Chloride	5.50	-	18	21	24,948	0	0	No
Xylene	5	-	9	21	1.22E+07	0	0	No

N/A = Not available.

Table A1.3
Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil in the LWNEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	Lowest ESL	Number of Nondetected Results > ESL	Percent Nondetected Results > ESL	Analyte Detected?
Inorganic (mg/kg)								
Cesium	120	-	140	4	N/A	0	0	No
Chromium VI	1.10	-	1.10	1	1.34	0	0	No
Thallium	0.330	-	1.10	21	1	2	9.52	Yes
Uranium	1.60	-	2.20	14	5	0	0	No
Organic (ug/kg)								
1,1,1,2-Tetrachloroethane	5.80	-	6.40	8	N/A	0	0	No
1,1,1-Trichloroethane	5.80	-	6.40	8	551,453	0	0	No
1,1,2,2-Tetrachloroethane	5.80	-	6.40	8	60,701	0	0	No
1,1,2-Trichloro-1,2,2-trifluoroethane	5.80	-	6.40	8	N/A	0	0	No
1,1,2-Trichloroethane	5.80	-	6.40	8	N/A	0	0	No
1,1-Dichloroethane	5.80	-	6.40	8	3,121	0	0	No
1,1-Dichloroethene	5.80	-	6.40	8	16,909	0	0	No
1,1-Dichloropropene	5.80	-	6.40	8	N/A	0	0	No
1,2,3-Trichlorobenzene	5.80	-	6.40	8	N/A	0	0	No
1,2,3-Trichloropropane	5.80	-	6.40	8	13,883	0	0	No
1,2,4-Trichlorobenzene	5.80	-	450	12	777	0	0	No
1,2,4-Trimethylbenzene	5.80	-	6.40	8	N/A	0	0	No
1,2-Dibromo-3-chloropropane	5.80	-	6.40	8	N/A	0	0	No
1,2-Dibromoethane	5.80	-	6.40	8	N/A	0	0	No
1,2-Dichlorobenzene	5.80	-	450	12	N/A	0	0	No
1,2-Dichloroethane	5.80	-	6.40	8	2,764	0	0	No
1,2-Dichloropropane	5.80	-	6.40	8	49,910	0	0	No
1,3,5-Trimethylbenzene	5.80	-	6.40	8	7,598	0	0	No
1,3-Dichlorobenzene	5.80	-	450	12	N/A	0	0	No
1,3-Dichloropropane	5.80	-	6.40	8	N/A	0	0	No
2,2-Dichloropropane	5.80	-	6.40	8	N/A	0	0	No
2,4,5-Trichlorophenol	2,000	-	2,200	4	4,000	0	0	No
2,4,6-Trichlorophenol	410	-	450	4	161	4	100	No
2,4-Dichlorophenol	410	-	450	4	2,744	0	0	No
2,4-Dimethylphenol	410	-	450	4	N/A	0	0	No
2,4-Dinitrophenol	2,000	-	2,200	4	20,000	0	0	No
2,4-Dinitrotoluene	410	-	450	4	32.1	4	100	No
2,6-Dinitrotoluene	410	-	450	4	6,186	0	0	No
2-Butanone	116	-	128	8	1.07E+06	0	0	No
2-Chloronaphthalene	410	-	450	4	N/A	0	0	No
2-Chlorophenol	410	-	450	4	281	4	100	No
2-Chlorotoluene	5.80	-	6.40	8	N/A	0	0	No
2-Hexanone	57.8	-	64.2	8	N/A	0	0	No
2-Methylnaphthalene	410	-	450	4	2,769	0	0	No
2-Methylphenol	410	-	450	4	123,842	0	0	No
2-Nitroaniline	2,000	-	2,200	4	5,659	0	0	No
2-Nitrophenol	410	-	450	4	N/A	0	0	No
3,3'-Dichlorobenzidine	830	-	900	4	N/A	0	0	No
3-Nitroaniline	2,000	-	2,100	3	N/A	0	0	No
4,4'-DDD	20	-	22	4	13,726	0	0	No
4,4'-DDE	20	-	70	4	7.95	4	100	No
4,6-Dinitro-2-methylphenol	2,000	-	2,200	4	560	4	100	No
4-Bromophenyl-phenylether	410	-	450	4	N/A	0	0	No
4-Chloro-3-methylphenol	410	-	450	4	N/A	0	0	No
4-Chloroaniline	410	-	450	4	716	0	0	No
4-Chlorophenyl-phenyl ether	410	-	450	4	N/A	0	0	No
4-Chlorotoluene	5.80	-	6.40	8	N/A	0	0	No
4-Isopropyltoluene	5.80	-	6.40	8	N/A	0	0	No
4-Methyl-2-pentanone	57.8	-	64.2	8	14,630	0	0	No
4-Methylphenol	410	-	450	4	N/A	0	0	No

Table A1.3
Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil in the LWNEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	Lowest ESL	Number of Nondetected Results > ESL	Percent Nondetected Results > ESL	Analyte Detected?
4-Nitroaniline	2,000	-	2,200	4	41,050	0	0	No
4-Nitrophenol	2,000	-	2,200	4	7,000	0	0	No
Acenaphthene	410	-	450	4	20,000	0	0	No
Acenaphthylene	410	-	450	4	N/A	0	0	No
Acetone	116	-	128	8	6,182	0	0	No
Aldrin	10	-	11	4	47.0	0	0	No
alpha-BHC	10	-	14	4	18,662	0	0	No
alpha-Chlordane	100	-	110	4	289	0	0	No
Anthracene	410	-	450	4	N/A	0	0	No
Benzene	5.80	-	6.40	8	500	0	0	No
Benzo(a)anthracene	410	-	450	4	N/A	0	0	No
Benzo(a)pyrene	410	-	450	4	631	0	0	No
Benzo(b)fluoranthene	410	-	450	4	N/A	0	0	No
Benzo(g,h,i)perylene	410	-	450	4	N/A	0	0	No
Benzo(k)fluoranthene	410	-	450	4	N/A	0	0	No
Benzyl Alcohol	410	-	450	4	4,403	0	0	No
beta-BHC	10	-	11	4	207	0	0	No
beta-Chlordane	100	-	110	4	289	0	0	No
bis(2-Chloroethoxy) methane	410	-	450	4	N/A	0	0	No
bis(2-Chloroethyl) ether	410	-	450	4	N/A	0	0	No
bis(2-Chloroisopropyl) ether	410	-	450	4	N/A	0	0	No
Bromobenzene	5.80	-	6.40	8	N/A	0	0	No
Bromochloromethane	5.80	-	6.40	8	N/A	0	0	No
Bromodichloromethane	5.80	-	6.40	8	5,750	0	0	No
Bromoform	5.80	-	6.40	8	2,855	0	0	No
Bromomethane	5.80	-	6.40	8	N/A	0	0	No
Butylbenzylphthalate	410	-	450	4	24,155	0	0	No
Carbon Disulfide	5.80	-	6.40	8	5,676	0	0	No
Carbon Tetrachloride	5.80	-	6.40	8	8,906	0	0	No
Chlorobenzene	5.80	-	6.40	8	4,750	0	0	No
Chloroethane	5.80	-	6.40	8	N/A	0	0	No
Chloroform	5.80	-	6.40	8	8,655	0	0	No
Chloromethane	5.80	-	6.40	8	N/A	0	0	No
Chrysene	410	-	450	4	N/A	0	0	No
cis-1,2-Dichloroethene	5.80	-	6.40	8	1,814	0	0	No
cis-1,3-Dichloropropene	5.80	-	6.40	8	2,800	0	0	No
Dibenz(a,h)anthracene	410	-	450	4	N/A	0	0	No
Dibenzofuran	410	-	450	4	21,200	0	0	No
Dibromochloromethane	5.80	-	6.40	8	5,730	0	0	No
Dibromomethane	5.80	-	6.40	8	N/A	0	0	No
Dichlorodifluoromethane	5.80	-	6.40	8	855	0	0	No
Dieldrin	20	-	25	4	7.40	4	100	No
Diethylphthalate	410	-	450	4	100,000	0	0	No
Dimethylphthalate	410	-	450	4	200,000	0	0	No
Di-n-butylphthalate	410	-	450	4	15.9	4	100	No
Di-n-octylphthalate	410	-	450	4	731,367	0	0	No
Endosulfan I	10	-	11	4	80.1	0	0	No
Endosulfan II	20	-	22	4	80.1	0	0	No
Endosulfan sulfate	20	-	29	4	80.1	0	0	No
Endrin	20	-	22	4	1.40	4	100	No
Endrin ketone	20	-	22	4	1.40	4	100	No
Ethylbenzene	5.80	-	6.40	8	N/A	0	0	No
Fluoranthene	410	-	450	4	N/A	0	0	No
Fluorene	410	-	450	4	30,000	0	0	No
gamma-BHC (Lindane)	10	-	11	4	25.9	0	0	No
Heptachlor	10	-	11	4	63.3	0	0	No

Table A1.3
Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil in the LWNEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	Lowest ESL	Number of Nondetected Results > ESL	Percent Nondetected Results > ESL	Analyte Detected?
Heptachlor epoxide	10	-	14	4	64.0	0	0	No
Hexachlorobenzene	410	-	450	4	7.73	4	100	No
Hexachlorobutadiene	5.80	-	450	12	431	1	8.33	No
Hexachlorocyclopentadiene	410	-	450	4	5,518	0	0	No
Hexachloroethane	410	-	450	4	366	4	100	No
Indeno(1,2,3-cd)pyrene	410	-	450	4	N/A	0	0	No
Isophorone	410	-	450	4	N/A	0	0	No
Isopropylbenzene	5.80	-	6.40	8	N/A	0	0	No
Methoxychlor	100	-	110	4	1,226	0	0	No
Naphthalene	5.80	-	450	12	27,048	0	0	No
n-Butylbenzene	5.80	-	6.40	8	N/A	0	0	No
Nitrobenzene	410	-	450	4	40,000	0	0	No
N-Nitroso-di-n-propylamine	410	-	450	4	N/A	0	0	No
N-nitrosodiphenylamine	410	-	450	4	20,000	0	0	No
n-Propylbenzene	5.80	-	6.40	8	N/A	0	0	No
PCB-1016	100	-	110	4	172	0	0	No
PCB-1221	100	-	110	4	172	0	0	No
PCB-1232	100	-	110	4	172	0	0	No
PCB-1242	100	-	100	4	172	0	0	No
PCB-1248	100	-	100	4	172	0	0	No
PCB-1254	200	-	220	4	172	4	100	No
PCB-1260	200	-	220	4	172	4	100	No
Pentachlorophenol	2,000	-	2,200	4	122	4	100	No
Phenanthrene	410	-	450	4	N/A	0	0	No
Phenol	410	-	450	4	23,090	0	0	No
Pyrene	410	-	450	4	N/A	0	0	No
sec-Butylbenzene	5.80	-	6.40	8	N/A	0	0	No
Styrene	5.80	-	6.40	8	16,408	0	0	No
tert-Butylbenzene	5.80	-	6.40	8	N/A	0	0	No
Toluene	5.80	-	6.40	8	14,416	0	0	No
Toxaphene	200	-	220	4	3,756	0	0	No
trans-1,2-Dichloroethene	5.80	-	6.40	8	25,617	0	0	No
trans-1,3-Dichloropropene	5.80	-	6.40	8	2,800	0	0	No
Trichloroethene	5.80	-	6.40	8	389	0	0	No
Trichlorofluoromethane	5.80	-	6.40	8	N/A	0	0	No
Vinyl Chloride	5.80	-	6.40	8	97.7	0	0	No
Xylene	5.80	-	6.40	8	1,140	0	0	No

N/A = Not available.

Table A1.4
Sitewide Summary Statistics for Analytes in Surface Soil with an Ecological Screening Level

Analyte	Total Number of Results	Detection Frequency (%)	Number of Detects	Minimum Detected Conc.	Maximum Detected Conc.	Minimum Nondetected Result	Maximum Nondetected Result	Minimum ESL
Inorganics (mg/kg)								
Aluminum	2,622	99.9	2,620	1,450	61,000	10.9	70	50
Ammonia	32	78.1	25	0.335	4.81	0.338	6.12	586
Antimony	2,482	20.0	497	0.270	348	0.0360	19.3	0.905
Arsenic	2,613	99.0	2,586	0.290	56.2	0.400	6.20	2.57
Barium	2,624	99.9	2,622	0.640	1,500	2.20	95	159
Beryllium	2,623	81.7	2,142	0.0710	26.8	0.0620	1.90	6.82
Boron	1,303	85.7	1,117	0.350	28	0.340	7	0.500
Cadmium	2,603	36.1	940	0.0600	270	0.0300	2.80	0.705
Chromium	2,624	99.2	2,604	1.20	210	2.20	19.8	0.400
Chromium VI	17	5.88	1.000	0.850	0.850	0.530	1.20	1.34
Cobalt	2,622	98.1	2,573	1.10	137	2.10	10.4	13
Copper	2,621	98.2	2,575	1.70	1,860	2.20	22.8	8.25
Cyanide	245	2.45	6.00	0.170	0.290	0.180	4.70	607
Fluoride	9	100	9	1.87	3.61	NA	NA	1.33
Lead	2,618	100	2,618	0.870	814	NA	NA	12.1
Lithium	2,433	94.5	2,300	0.990	50	1.60	20.6	2
Manganese	2,617	99.9	2,615	15	2,220	2.20	130	486
Mercury	2,541	48.8	1,239	0.00140	48	0.00120	0.190	1.00E-04
Molybdenum	2,421	47.0	1,138	0.140	19.1	0.0990	7.50	1.84
Nickel	2,620	97.5	2,554	1.90	280	1.60	19.1	0.431
Nitrate / Nitrite	450	83.3	375	0.216	765	0.200	5.60	4,478
Selenium	2,590	13.3	345	0.220	2.20	0.0540	4.50	0.754
Silver	2,589	28.4	735	0.0580	364	0.0490	7	2
Strontium	2,423	100.0	2,422	2.40	413	1.10	1.10	940
Thallium	2,597	14.1	366	0.100	5.80	0.0160	2.50	1
Tin	2,423	10.0	243	0.289	161	0.0780	58.5	2.90
Uranium	1,296	8.80	114	0.430	370	0.130	16.8	5
Vanadium	2,622	100.0	2,621	4.40	5,300	2.20	2.20	2
Zinc	2,622	99.8	2,617	4.20	11,900	2.20	99.8	0.646
Organics (ug/kg)								
1,1,1-Trichloroethane	633	1.58	10.00	1.10	47.7	0.587	680	551,453
1,1,2,2-Tetrachloroethane	632	0.158	1.000	1.39	1.39	0.527	680	60,701
1,1-Dichloroethane	633	0	0	NA	NA	0.512	680	3,121
1,1-Dichloroethene	633	0.158	1.000	7.90	7.90	0.610	680	16,909
1,2,3-Trichloropropane	517	0.193	1.000	1.47	1.47	0.525	129	13,883

Table A1.4
Sitewide Summary Statistics for Analytes in Surface Soil with an Ecological Screening Level

Analyte	Total Number of Results	Detection Frequency (%)	Number of Detects	Minimum Detected Conc.	Maximum Detected Conc.	Minimum Nondetected Result	Maximum Nondetected Result	Minimum ESL
1,2,4-Trichlorobenzene	1,549	0.323	5.00	0.870	150	0.621	7,000	777
1,2-Dichloroethane	629	0	0	NA	NA	0.522	680	2,764
1,2-Dichloroethene	101	0.990	1.000	16	16	5	680	25,617
1,2-Dichloropropane	633	0.316	2.00	18	140	0.413	680	49,910
1,3,5-Trimethylbenzene	515	6.60	34.0	0.610	490	0.535	65.2	7,598
1,4-Dichlorobenzene	1,329	0.677	9.00	0.450	110	0.649	6,900	20,000
2,4,5-T	9	11.1	1.000	1.80	1.80	21	100	162
2,4,5-Trichlorophenol	1,180	0.0847	1.000	1,100	1,100	330	34,000	4,000
2,4,6-Trichlorophenol	1,180	0.0847	1.000	950	950	330	7,000	161
2,4,6-Trinitrotoluene	8	12.5	1	56	56	0.220	250	283
2,4-DB	9	0	0	NA	NA	83	100	426
2,4-Dichlorophenol	1,180	0	0	NA	NA	330	7,000	2,744
2,4-Dinitrophenol	1,173	0	0	NA	NA	850	35,000	20,000
2,4-Dinitrotoluene	1,232	0	0	NA	NA	250	7,000	32.1
2,6-Dinitrotoluene	1,232	0	0	NA	NA	250	7,000	6,186
2378-TCDD	22	68.2	15.0	2.59E-05	0.00680	2.20E-04	0.00106	0.00425
2-Butanone	631	2.54	16.0	3	155	2.72	1,400	1.07E+06
2-Chlorophenol	1,180	0	0	NA	NA	330	7,000	281
2-Methylnaphthalene	1,223	6.95	85.0	34	12,000	330	7,000	2,769
2-Methylphenol	1,180	0	0	NA	NA	330	7,000	123,842
2-Nitroaniline	1,224	0	0	NA	NA	370	35,000	5,659
4,4'-DDD	468	0.427	2.00	3.50	10	1.80	190	13,726
4,4'-DDE	468	1.50	7.00	0.600	7.20	1.80	190	7.95
4,4'-DDT	468	0.855	4.00	9.10	26	1.80	190	1.20
4,6-Dinitro-2-methylphenol	1,176	0.0850	1.000	390	390	850	35,000	560
4-Chloroaniline	1,217	0	0	NA	NA	330	14,000	716
4-Methyl-2-pentanone	630	2.38	15.0	4	73	1.94	2,960	14,630
4-Nitroaniline	1,218	0.328	4.00	62	820	850	55,000	41,050
4-Nitrophenol	1,169	0.171	2.00	53	320	850	35,000	7,000
4-Nitrotoluene	5	0	0	NA	NA	250	250	61,422
Acenaphthene	1,239	22.3	276	21	44,000	330	6,900	20,000
Acetone	632	19.3	122	1.70	1,280	2.65	2,960	6,182
Aldrin	468	0.855	4.00	0.590	17	1.80	95	47.0
alpha-BHC	468	0.214	1.000	7.90	7.90	1.80	95	18,662
alpha-Chlordane	433	0	0	NA	NA	1.80	950	289
Benzene	633	0.948	6.00	1	11	0.502	680	500

Table A1.4
Sitewide Summary Statistics for Analytes in Surface Soil with an Ecological Screening Level

Analyte	Total Number of Results	Detection Frequency (%)	Number of Detects	Minimum Detected Conc.	Maximum Detected Conc.	Minimum Nondetected Result	Maximum Nondetected Result	Minimum ESL
Benzo(a)pyrene	1,235	41.2	509	36	43,000	19	7,000	631
Benzyl Alcohol	1,114	0.718	8.00	140	2,800	330	14,000	4,403
beta-BHC	467	0.428	2.00	11	11	1.80	95	207
beta-Chlordane	411	0.243	1.000	2.60	2.60	1.80	950	289
bis(2-ethylhexyl)phthalate	1,227	29.7	365	29	75,000	330	7,000	137
Bromodichloromethane	633	0	0	NA	NA	0.502	680	5,750
Bromoform	633	0	0	NA	NA	0.525	680	2,855
Butylbenzylphthalate	1,226	9.79	120	35	7,100	330	7,000	24,155
Carbon Disulfide	633	0.158	1.000	4	4	0.535	680	5,676
Carbon Tetrachloride	633	3.32	21.0	0.340	103	0.575	680	8,906
Chlordane	34	0	0	NA	NA	18	220	289
Chlorobenzene	633	0.316	2.00	2	2.03	0.484	680	4,750
Chloroform	633	1.11	7.00	1.30	7	0.543	680	8,655
cis-1,2-Dichloroethene	517	1.74	9.00	1.10	15	0.502	590	1,814
cis-1,3-Dichloropropene	633	0	0	NA	NA	0.502	680	2,800
delta-BHC	468	0.214	1.000	23	23	1.80	95	25.9
Dibenzofuran	1,227	10.9	134	36	20,000	330	7,000	21,200
Dibromochloromethane	633	0	0	NA	NA	0.502	680	5,730
Dicamba	9	55.6	5.00	2.30	150	42	100	1,690
Dichlorodifluoromethane	499	0	0	NA	NA	1.73	398	855
Dieldrin	468	2.35	11.0	1.80	92	1.80	190	7.40
Diethylphthalate	1,224	0.654	8.00	33	420	330	7,000	100,000
Dimethoate	7	0	0	NA	NA	18	180	13.7
Dimethylphthalate	1,227	1.47	18.0	69	460	330	7,000	200,000
Di-n-butylphthalate	1,227	7.99	98.0	35	10,000	330	7,000	15.9
Di-n-octylphthalate	1,225	3.92	48.0	38	11,000	330	7,000	731,367
Endosulfan I	468	0.427	2.00	3.90	7.40	1.80	95	80.1
Endosulfan II	461	0.651	3.00	0.700	9.90	1.80	170	80.1
Endosulfan sulfate	468	0.641	3.00	5.50	24	1.80	190	80.1
Endrin	468	1.28	6.00	2.40	17	1.80	200	1.40
Endrin aldehyde	66	3.03	2.00	8.70	9.20	1.80	38	1.40
Endrin ketone	437	0.229	1.000	36	36	1.80	190	1.40
Fluorene	1,244	18.8	234	27	39,000	140	7,000	30,000
gamma-BHC (Lindane)	468	0.214	1.000	8.30	8.30	1.80	95	25.9
gamma-Chlordane	23	0	0	NA	NA	2	260	289
Heptachlor	468	0	0	NA	NA	1.80	95	63.3

Table A1.4
Sitewide Summary Statistics for Analytes in Surface Soil with an Ecological Screening Level

Analyte	Total Number of Results	Detection Frequency (%)	Number of Detects	Minimum Detected Conc.	Maximum Detected Conc.	Minimum Nondetected Result	Maximum Nondetected Result	Minimum ESL
Heptachlor epoxide	467	0.642	3.00	7.20	23	1.80	95	64.0
Hexachlorobenzene	1,224	0.327	4.00	110	380	330	7,000	7.73
Hexachlorobutadiene	1,550	0.0645	1.000	2.20	2.20	0.508	7,000	431
Hexachlorocyclopentadiene	1,208	0	0	NA	NA	330	7,000	5,518
Hexachloroethane	1,227	0	0	NA	NA	330	7,000	366
HMX	5	20	1	230	230	250	250	16,012
Methoxychlor	468	1.71	8.00	0.280	450	3.50	950	1,226
Methylene Chloride	631	12.0	76.0	0.790	45	0.502	2,200	3,399
Naphthalene	1,567	14.1	221	0.850	41,000	0.751	7,000	27,048
Nitrobenzene	1,218	0	0	NA	NA	250	7,000	40,000
N-nitrosodiphenylamine	1,227	0	0	NA	NA	330	7,000	20,000
PCB-1016	795	0.755	6.00	13	95	33	4,500	172
PCB-1221	845	0	0	NA	NA	33	4,500	172
PCB-1232	845	0	0	NA	NA	33	4,500	172
PCB-1242	845	0.237	2.00	23	350	33	4,500	172
PCB-1248	845	0.710	6.00	17	840	33	4,500	172
PCB-1254	842	17.9	151	6.80	8,900	33	9,000	172
PCB-1260	838	17.2	144	6.20	7,800	33	4,300	172
Pentachlorophenol	1,180	1.02	12.0	39	39,000	850	35,000	122
Phenol	1,180	0.424	5.00	33	130	330	7,000	23,090
Styrene	633	0.158	1.000	7.80	7.80	0.550	680	16,408
Tetrachloroethene	633	8.53	54.0	0.380	29,000	0.641	680	763
Toluene	633	9.00	57.0	0.0990	990	0.528	60.8	14,416
Toxaphene	468	0	0	NA	NA	86	2,200	3,756
trans-1,2-Dichloroethene	532	0	0	NA	NA	0.738	93.3	25,617
trans-1,3-Dichloropropene	633	0	0	NA	NA	0.502	680	2,800
Trichloroethene	633	4.11	26.0	0.170	200	0.500	680	389
Vinyl acetate	78	0	0	NA	NA	10	1,400	13,986
Vinyl Chloride	633	0	0	NA	NA	0.748	1,400	97.7
Xylene	633	10.4	66.0	0.600	933	0.502	680	1,140

NA = Not applicable.

Table A1.5
Summary of Professional Judgment and Ecological Risk Potential

Analyte	Summary of Professional Judgment								Ecological Risk Potential						
	Listed as Waste Constituent for LWNEU Historical IHSSs ?[1]	Historical RFETS Inventory [2] (1974/1988) (kg)	Maximum Conc. in Soil Sitewide (ug/kg)	Detection Frequency in Sitewide Soil (%)	Maximum Conc. in LWNEU Soil (ug/kg)	Detection Frequency in LWNEU Soil (%)	Potential to be an ECOPC?	Uncertainty Category[3]	Lowest ESL (ug/kg)	Most Sensitive Receptor [4]	LOAEL/ NOAEL [5]	LOAEL-Based Soil Conc. (ug/kg)	Maximum Reported Result for Non-detects in LWNEU (ug/kg)	Maximum Reported Result/ LOAEL-Based Soil Conc. [6]	Potential for Adverse Effects if Detected at Reported Results Levels?
2,4,6-Trichlorophenol	No	0/.01	950	.1	N/A	0	No	2	160.5	Deer Mouse Insectivore	100	16050	450	0.02	No
2,4-Dinitrotoluene	No	0/0	N/A	0	N/A	0	No	1	32.1	Deer Mouse Insectivore	10	321	450	1	No
2-Chlorophenol	No	0.12/0.02	N/A	0	N/A	0	No	1	281	Deer Mouse Insectivore	100	28100	450	0.02	No
4,4'-DDE	No	0/0.001	7.2	1.5	N/A	0	No	2	8.0	Mourning Dove Insectivore	10	80	70	0.9	No
4,6-Dinitro-2-methylphenol	No	0/0	390	0.1	N/A	0	No	2	560.4	Deer Mouse Insectivore	20	11208	2200	0.2	No
Dieldrin	No	0/0.003	92	2.4	N/A	0	No	2	7.4	Deer Mouse Insectivore	2	14.8	25	2	Yes
Di-n-butylphthalate	No	0/0.005	10000	8.0	N/A	0	No	2	15.9	Mourning Dove Insectivore	10	159	450	3	Yes
Endrin	No	0/0.004	17	1.3	N/A	0	No	2	1.4	Mourning Dove Insectivore	10	14	22	2	Yes
Endrin ketone	No	0/0	36	0.2	N/A	0	No	2	1.4	Mourning Dove Insectivore	10	14	22	2	Yes
Hexachlorobenzene	No	1.000/1.005	380	0.3	N/A	0	No	2	7.7	Mourning Dove Insectivore	40	308	450	1	No
Hexachloroethane	No	0.02/0.02	N/A	0	N/A	0	No	1	366.2	Deer Mouse Insectivore	20	7324	450	0.06	No
PCB-1254	No	0/0.017	8900	17.9	N/A	0	No	2	172	Mourning Dove Insectivore	14.1	2425	220	0.09	No
PCB-1260	No	0/0.018	7800	17.2	N/A	0	No	2	172	Mourning Dove Insectivore	14.1	2425	220	0.09	No
Pentachlorophenol	No	0.02/0.02	39000	1.0	N/A	0	No	2	122	Deer Mouse Insectivore	10	1220	2200	2	Yes

[1] Includes listing of the class of compound, e.g., herbicides, pesticides, chlorinated solvents, polynuclear aromatic hydrocarbons, etc. Ref. DOE, 2005a.
[2] CDH, 1991.
[3] See text for explanation.
[4] Basis for the lowest ESL.
[5] LOAELs and NOAELs from Appendix B, Table B-2, “TRVs for Terrestrial Vertebrate Receptors”, Ref. DOE 2005b.
[6] Ratios are rounded to one significant figure.
CDH – Colorado Department of Health
DDE – dichlorodiphenyldichloroethylene
DOE – Department of Energy
ESL – Ecological Screening Level
IHSS – Individual Hazardous Substance Site
LOAEL – Lowest Bounded Lowest Observed Adverse Effect Level
NOAEL - Final No Observed Adverse Effect Level
RFETS – Rocky Flats Environmental Technology Site
LWNEU – Lower Walnut Drainage Exposure Unit
NA – Not applicable

Table A1.6
Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Subsurface Soil in the LWNEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	Lowest ESL	Number of Nondetected Results > ESL	Percent Nondetected Results > ESL	Analyte Detected?
Inorganic (mg/kg)								
Antimony	0.510	-	15.1	13	18.7	0	0	No
Cadmium	0.430	-	0.997	14	198	0	0	No
Organic (ug/kg)								
1,1,1,2-Tetrachloroethane	5.50	-	6.20	8	N/A	0	0	No
1,1,1-Trichloroethane	5	-	6.20	16	4.85E+07	0	0	No
1,1,2,2-Tetrachloroethane	5	-	6.20	16	4.70E+06	0	0	No
1,1,2-Trichloro-1,2,2-trifluoroethane	5.50	-	6.20	8	N/A	0	0	No
1,1,2-Trichloroethane	5	-	6.20	16	N/A	0	0	No
1,1-Dichloroethane	5	-	6.20	16	215,360	0	0	No
1,1-Dichloroethene	5	-	6.20	16	1.28E+06	0	0	No
1,1-Dichloropropene	5.50	-	6.20	8	N/A	0	0	No
1,2,3-Trichlorobenzene	5.50	-	6.20	8	N/A	0	0	No
1,2,3-Trichloropropane	5.50	-	6.20	8	1.17E+06	0	0	No
1,2,4-Trichlorobenzene	5.50	-	6.20	8	94,484	0	0	No
1,2,4-Trimethylbenzene	5.50	-	6.20	8	N/A	0	0	No
1,2-Dibromo-3-chloropropane	5.50	-	6.20	8	N/A	0	0	No
1,2-Dibromoethane	5.50	-	6.20	8	N/A	0	0	No
1,2-Dichlorobenzene	5.50	-	6.20	8	N/A	0	0	No
1,2-Dichloroethane	5	-	6.20	16	2.00E+06	0	0	No
1,2-Dichloroethene	5	-	6	8	1.87E+06	0	0	No
1,2-Dichloropropane	5	-	6.20	16	3.92E+06	0	0	No
1,3,5-Trimethylbenzene	5.50	-	6.20	8	855,709	0	0	No
1,3-Dichlorobenzene	5.50	-	6.20	8	N/A	0	0	No
1,3-Dichloropropane	5.50	-	6.20	8	N/A	0	0	No
2,2-Dichloropropane	5.50	-	6.20	8	N/A	0	0	No
2-Butanone	11	-	124	14	4.94E+07	0	0	No
2-Chlorotoluene	5.50	-	6.20	8	N/A	0	0	No
2-Hexanone	11	-	62.1	14	N/A	0	0	No
4-Chlorotoluene	5.50	-	6.20	8	N/A	0	0	No
4-Isopropyltoluene	5.50	-	6.20	8	N/A	0	0	No
4-Methyl-2-pentanone	11	-	62.1	14	859,131	0	0	No
Benzene	5	-	6.20	16	1.10E+06	0	0	No
Bromobenzene	5.50	-	6.20	8	N/A	0	0	No
Bromochloromethane	5.50	-	6.20	8	N/A	0	0	No
Bromodichloromethane	5	-	6.20	16	381,135	0	0	No
Bromoform	5	-	6.20	16	198,571	0	0	No
Bromomethane	5.50	-	12	15	N/A	0	0	No
Carbon Disulfide	5	-	6.20	16	410,941	0	0	No
Carbon Tetrachloride	5	-	6.20	16	736,154	0	0	No
Chlorobenzene	5	-	6.20	16	413,812	0	0	No
Chloroethane	5.50	-	12	15	N/A	0	0	No
Chloroform	5	-	6.20	16	560,030	0	0	No
Chloromethane	5.50	-	12	16	N/A	0	0	No
cis-1,2-Dichloroethene	5.50	-	6.20	8	132,702	0	0	No
cis-1,3-Dichloropropene	5	-	6.20	16	222,413	0	0	No
Dibromochloromethane	5	-	6.20	16	389,064	0	0	No
Dibromomethane	5.50	-	6.20	8	N/A	0	0	No
Dichlorodifluoromethane	5.50	-	6.20	8	59,980	0	0	No
Ethylbenzene	5	-	6.20	16	N/A	0	0	No
Hexachlorobutadiene	5.50	-	6.20	8	150,894	0	0	No
Isopropylbenzene	5.50	-	6.20	8	N/A	0	0	No
Naphthalene	5.50	-	6.20	8	1.60E+07	0	0	No
n-Butylbenzene	5.50	-	6.20	8	N/A	0	0	No
n-Propylbenzene	5.50	-	6.20	8	N/A	0	0	No
sec-Butylbenzene	5.50	-	6.20	8	N/A	0	0	No
Styrene	5	-	6.20	16	1.53E+06	0	0	No
tert-Butylbenzene	5.50	-	6.20	8	N/A	0	0	No
Tetrachloroethene	5	-	6.20	16	72,494	0	0	No
trans-1,2-Dichloroethene	5.50	-	6.20	8	1.87E+06	0	0	No
trans-1,3-Dichloropropene	5	-	6.20	16	222,413	0	0	No

Table A1.6
Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Subsurface Soil in the LWNEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	Lowest ESL	Number of Nondetected Results > ESL	Percent Nondetected Results > ESL	Analyte Detected?
Trichloroethene	5	-	6.20	16	32,424	0	0	No
Trichlorofluoromethane	5.50	-	6.20	8	N/A	0	0	No
Vinyl acetate	11	-	12	6	730,903	0	0	No
Vinyl Chloride	5.50	-	12	16	6,494	0	0	No
Xylene	5	-	6.20	16	111,663	0	0	No

N/A = Not available.

COMPREHENSIVE RISK ASSESSMENT
LOWER WALNUT DRAINAGE EXPOSURE UNIT

VOLUME 8: ATTACHMENT 2
Data Quality Assessment

TABLE OF CONTENTS

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

AA	atomic absorption
ASD	Analytical Services Division
COC	contaminant of concern
CRA	Comprehensive Risk Assessment
CRDL	contract required detection limit
DAR	data adequacy report
DDT	4,4'-dichlorodiphenyltrichloroethane
DER	duplicate error ratio
DOE	U.S. Department of Energy
DQA	Data Quality Assessment
DQO	data quality objective
DRC	data review checklist
ECOPC	ecological contaminant of potential concern
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
EPC	Exposure point concentration
ESL	ecological screening level
EU	Exposure unit
FD	field duplicate
IAG	Interagency Agreement
ICP	inductively couple plasma
IDL	instrument detection limit
LCS	laboratory control sample
LWNEU	Lower Walnut Drainage Exposure Unit

MDA	minimum detectable activity
MDL	method detection limit
MS	matrix spike
MSA	method of standard additions
MSD	matrix spike duplicate
N/A	not applicable
PARCC	Precision, accuracy, representativeness, completeness, and comparability
PPT	Pipette
PRG	preliminary remediation goal
PCB	polychlorinated biphenyl
QC	quality control
RDL	Required detection limit
RFETS	Rocky Flats Environmental Technology Site
RI/FS	Remedial Investigation/Feasibility Study
RL	Reporting limit
RPD	relative percent difference
SDP	Standard data package
SOW	Statement of Work
SVOC	semi-volatile organic compound
SWD	Soil Water Database
TCLP	Toxicity Characteristic Leaching Procedure
TIC	tentatively identified compound
V&V	verification and validation
VOC	volatile organic compound

1.0 INTRODUCTION

This document provides an assessment of the quality of the data used in the human health and ecological risk assessments for the Lower Walnut Drainage Exposure Unit (LWNEU). The data quality was evaluated against standard precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters by the data validator under the multiple work plans that guided the data collection over the past 15 years, as well as the requirements for the PARCC parameters provided in the Comprehensive Risk Assessment (CRA) Methodology (DOE 2005). The details of this data quality assessment (DQA) process are presented in the Sitewide DQA contained in Appendix A, Volume 2, Attachment 2 of the Remedial Investigation/Feasibility Study (RI/FS).

Of the 32,209 environmental sampling records in the RFETS database associated with the LWNEU, 19,747 were used in the LWNEU risk assessment based on the data processing rules described in Section 2.0 of the Sitewide DQA. Of the 19,747 analytical records existing in the LWNEU CRA data set, 77 percent (15,166 records) have undergone verification or validation (V&V) (Table A2.1). The V&V review involved applying observation notes and qualifiers flags or observation notes without qualifier flags to the data.

PARCC parameter analysis was used to determine if the data quality could affect the risk assessment decisions (i.e., have significant impact on risk calculations or selection of contaminants of concern [COCs] for human health or ecological contaminants of potential concern [ECOPCs]). In consultation with the data users and project team, the primary ways in which the PARCC parameters could impact the risk assessment decisions were identified and these include the following:

- Detect results are falsely identified as nondetects;
- Nondetect results are falsely identified as detects;
- Issues that cause detection limit uncertainty;
- Issues that cause significant overestimation of detect results; and
- Issues that cause significant underestimation of detect results.

2.0 SUMMARY OF FINDINGS

2.1 PARCC Findings

A summary of V&V observations and the associated affected PARCC parameter is presented in Table A2.2 by analyte group and matrix (i.e., “soil” includes soil and sediment, and “water” includes surface water and groundwater). Table A2.3 presents the

percentage of the LWNEU V&V data that were qualified as estimated and/or undetected by analyte group and matrix. Overall, less than 13 percent of the LWNEU CRA data were qualified as estimated or undetected. Approximately 3 percent of the data reported as detected by the laboratory were qualified as undetected by the validator due to blank contamination (Table A2.4). In general, data qualified as estimated or undetected are marked as such because of various laboratory noncompliance issues that are not serious enough to render the data unusable. The precision between field duplicate (FD)/target sample analyte pairs is summarized in Table A2.5.

Of the 77 percent of the LWNEU data set that underwent V&V, 83 percent were qualified as having no QC issues, and approximately 13 percent were qualified as estimated or undetected (Table A2.3). The remaining 4 percent of the V&V data are made up of records qualified with additional flags indicating acceptable and non-estimated data such as “A”, “C”, or “E”.

Approximately 3 percent of the entire data set was rejected during the V&V process (Table A2.6). Rejected data were removed from the LWNEU CRA data set during the data processing as defined in Section 2.0 of the Sitewide DQA.

The general discussion below summarizes the data quality as presented by the data validator’s observations. The relationship between these observations and the PARCC parameters can be found in the Sitewide DQA. Several observations have no impact on data quality because they represent issues that were noted but corrected, or represent other general observations, such as missing documentation that was not required for data assessment. Approximately 11 percent of the LWNEU V&V data were marked with these V&V observations that have no affect on any of the PARCC parameters.

Of the V&V data, approximately 2 percent were noted for observations related to precision. All of the V&V precision observations were related to sample matrix.

Of the V&V data, 27 percent were noted for accuracy-related observations. Of that 23 percent, 69 percent was noted for laboratory practice-related observations, while sample-specific accuracy observations make up the other 31 percent. It is important to note that not all accuracy-related observations resulted in data qualification. Only 13 percent of the LWNEU CRA data set was qualified as estimated and/or undetected (Table A2.3).

The data were determined to meet the representativeness parameter because sampling locations are spatially distributed such that contaminant randomness and bias considerations are addressed based on the site-specific history (see the Data Adequacy Report [DAR] in Appendix A, Volume 2, Attachment 3). Samples were also analyzed by the SW-846 or alpha-spectroscopy methods and results were documented as quality records according to approved procedures and guidelines (V&V).

Of the V&V data, approximately 30 percent were noted for observations related to representativeness. Of that 30 percent, 71 percent were marked for blank observations, 17 percent for failure to observe allowed holding times, 4 percent for documentation issues, and 4 percent for issues related to sample preparation.. Instrument set-up and

sensitivity, LCS, and other observations make up the other 4 percent of the data noted for observations related to sample representativeness. Reportable levels of target analytes were not routinely detected in the laboratory blanks greater than the laboratory RLs and samples were generally stored and preserved properly.

The CRA Methodology specifies completeness criteria based on data adequacy and these criteria and the findings are discussed in the DAR in Appendix A, Volume 2, Attachment 3 of the RI/FS. Additionally, it should be noted that less than 3 percent of all V&V data associated with the LWNEU were rejected.

Comparability of the LWNEU CRA data set is ensured as all analytical results have been converted into common units. Comparability is addressed more specifically in Appendix A, Volume 2, Attachment 2 of the RI/FS.

2.2 PARCC Findings Potential Impact on Data Usability

PARCC parameter influence on data usability is discussed below with an emphasis on the risk assessment decisions as described in the Introduction to this document.

Table A2.3 summarizes the overall percentage of qualified data, independent of validation observation. The table is used for overall guidance in selecting analyte group and matrix combinations of interest in the analysis of the risk assessment decisions, the impact on data usability is better analyzed using Tables A2.5 through A2.7, as these can be more directly related to the 5 key risk assessment decision factors described in the introduction.

A summary of FD/target sample precision information can be found in Table A2.5. Where there are analyte group and matrix combinations failures that have the potential to impact risk assessment decisions, the data quality is discussed in further detail in the bulleted list below.

Table A2.7 lists V&V observations where the number of observations by analyte group and matrix exceeds 5 percent of the associated records (see column “Percent Observed”) with the exception of those observations that were determined to have no impact on any of the PARCC parameters. Such observations are identified in Table A2.2 by an “Affected PARCC Parameter” of not applicable (N/A). Additionally the analyte group and matrix is broken down further in the columns “Percent Qualified U” and “Percent Qualified J”. Data qualifications that are considered to have potential impact on risk assessment decisions were reviewed and are discussed in detail in the bulleted list below. Other issues are not considered to have the potential for significant impacts on the results of the risk assessments because the uncertainty associated with these data quality issues is assumed to be less than the overall uncertainty in the risk assessment process (e.g., uncertainties such as exposure assumptions, toxicity values, and statistical methods for calculating exposure point concentrations).

Data qualifications associated with the water matrix are not discussed in the bulleted list below. Surface water data are used in the ecological risk assessment for an EU only for those analytes identified as ECOPCs, and the surface water component of exposure contributes only minimally to the overall risk estimates. As described in the Sitewide DQA (Attachment 2 of Volume 2 of Appendix A of the RI/FS Report), groundwater data are not used in the ecological risk assessment and the groundwater evaluations for the human health portion of the risk assessment are performed on a sitewide basis. In addition, surface water is evaluated for the human health risk assessment on a sitewide basis. Therefore, data quality evaluations for groundwater and surface water are presented in the Sitewide DQA.

Issues that have the potential to impact the risk assessment decisions include the following:

- Approximately 11 percent of all metal/soil FD/target sample analyte pairs failed relative percent difference (RPD) criteria (Table A2.5). While some imprecision in the associated data may be indicated by this data quality observation, it is important to note that no metals were chosen either as COCs or as ECOPCs in the LWNEU risk assessment, and that all FD and target sample results were within an order of magnitude of one another. The possible data imprecision is therefore, not significant enough to have greatly impacted risk assessment decisions.

- Several V&V observations related to the wet chemistry/soil analyte group and matrix combination resulted in data qualifications in notable percentages of the data set (Table A2.7). It is important to note, however, that this analyte group contains general chemistry parameters such as ions/anions and alkalinity that are not directly related to site characterization. Therefore, the impact of these qualifications on risk assessment results is determined to be minimal.

3.0 CONCLUSIONS

This review concludes that the quality of the LWNEU data is acceptable and the CRA objectives for PARCC performance have generally been met. Where either CRA Methodology or V&V guidance have not been met, the data are either flagged by the V&V process, or for those instances where the frequency of issues may influence the risk assessment decisions, the data quality issues were reviewed for potential impact on risk assessment results.

Those elements of data quality that could affect risk assessment decisions in the LWNEU have been analyzed and it was concluded that the noted deviations from the PARCC parameter criteria have minimal impact on risk assessment results related to the LWNEU.

4.0 REFERENCES

DOE, 2002, Final Work Plan for the Development of the Remedial Investigation and Feasibility Study Report, Rocky Flats Environmental Technology Site, Golden, Colorado, March.

DOE, 2005. Final Comprehensive Risk Assessment Work Plan and Methodology, Environmental Restoration, Rocky Flats Environmental Technology Site, Golden, Colorado. Revision 1, September 2005.

TABLES

Table A2.1
CRA Data V&V Summary

Analyte Group	Matrix	Total No. of CRA V&V Records	Total No. of CRA Records	Percent V&V (%)
Dioxins and Furans	Water	3	3	100.00
Herbicide	Soil	12	12	100.00
Herbicide	Water	11	41	26.83
Metal	Soil	1,397	1,397	100.00
Metal	Water	3,967	4,542	87.34
PCB	Soil	84	84	100.00
PCB	Water	28	56	50.00
Pesticide	Soil	251	252	99.60
Pesticide	Water	92	203	45.32
Radionuclide	Soil	390	452	86.28
Radionuclide	Water	1,978	3,967	49.86
SVOC	Soil	751	754	99.60
SVOC	Water	747	1,023	73.02
VOC	Soil	1,490	1,558	95.64
VOC	Water	2,940	3,776	77.86
Wet Chem	Soil	35	35	100.00
Wet Chem	Water	990	1,592	62.19
	Total	**15,166**	**19,747**	**76.80%**

Table A2.2
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect	No. of Records w/ Noted Observation	Total No. of V&V Records	Percent Observed (%)	PARCC Parameter Affected
Dioxins and Furans	Water	Documentation Issues	Transcription error	No	1	3	33.33	N/A
Herbicide	Water	Documentation Issues	Transcription error	No	4	11	36.36	N/A
Metal	Soil	Blanks	Calibration verification blank contamination	No	65	1,397	4.65	Representativeness
Metal	Soil	Blanks	Calibration verification blank contamination	Yes	5	1,397	0.36	Representativeness
Metal	Soil	Blanks	Method, preparation, or reagent blank contamination	No	28	1,397	2.00	Representativeness
Metal	Soil	Blanks	Method, preparation, or reagent blank contamination	Yes	7	1,397	0.50	Representativeness
Metal	Soil	Blanks	Negative bias indicated in the blanks	No	2	1,397	0.14	Representativeness
Metal	Soil	Blanks	Negative bias indicated in the blanks	Yes	3	1,397	0.21	Representativeness
Metal	Soil	Calibration	Continuing calibration verification criteria were not met	No	2	1,397	0.14	Accuracy
Metal	Soil	Documentation Issues	Transcription error	No	1	1,397	0.07	N/A
Metal	Soil	Documentation Issues	Transcription error	Yes	10	1,397	0.72	N/A
Metal	Soil	Holding Times	Holding times were exceeded	No	1	1,397	0.07	Representativeness
Metal	Soil	Instrument Set-up	Interference was indicated in the interference check sample	Yes	5	1,397	0.36	Accuracy
Metal	Soil	LCS	CRDL check sample recovery criteria were not met	No	13	1,397	0.93	Accuracy
Metal	Soil	LCS	CRDL check sample recovery criteria were not met	Yes	8	1,397	0.57	Accuracy
Metal	Soil	LCS	LCS recovery criteria were not met	No	27	1,397	1.93	Accuracy
Metal	Soil	LCS	LCS recovery criteria were not met	Yes	55	1,397	3.94	Accuracy
Metal	Soil	LCS	Low level check sample recovery criteria were not met	No	8	1,397	0.57	Accuracy
Metal	Soil	LCS	Low level check sample recovery criteria were not met	Yes	19	1,397	1.36	Accuracy
Metal	Soil	Matrices	Duplicate sample precision criteria were not met	Yes	4	1,397	0.29	Precision

Table A2.2
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect	No. of Records w/ Noted Observation	Total No. of V&V Records	Percent Observed (%)	PARCC Parameter Affected
Metal	Soil	Matrices	LCS/LCSD precision criteria were not met	Yes	32	1,397	2.29	Precision
Metal	Soil	Matrices	Post-digestion MS did not meet control criteria	No	4	1,397	0.29	Accuracy
Metal	Soil	Matrices	Post-digestion MS did not meet control criteria	Yes	6	1,397	0.43	Accuracy
Metal	Soil	Matrices	Predigestion MS recovery criteria were not met	No	44	1,397	3.15	Accuracy
Metal	Soil	Matrices	Predigestion MS recovery criteria were not met	Yes	109	1,397	7.80	Accuracy
Metal	Soil	Matrices	Predigestion MS recovery was < 30 percent	Yes	2	1,397	0.14	Accuracy
Metal	Soil	Matrices	Serial dilution criteria were not met	Yes	98	1,397	7.02	Accuracy
Metal	Soil	Other	IDL is older than 3 months from date of analysis	No	37	1,397	2.65	Accuracy
Metal	Soil	Other	IDL is older than 3 months from date of analysis	Yes	87	1,397	6.23	Accuracy
Metal	Soil	Other	Result obtained through dilution	No	1	1,397	0.07	N/A
Metal	Soil	Other	Result obtained through dilution	Yes	4	1,397	0.29	N/A
Metal	Soil	Sensitivity	IDL changed due to a significant figure discrepancy	No	2	1,397	0.14	Representativeness
Metal	Water	Blanks	Calibration verification blank contamination	No	119	3,967	3.00	Representativeness
Metal	Water	Blanks	Calibration verification blank contamination	Yes	33	3,967	0.83	Representativeness
Metal	Water	Blanks	Method, preparation, or reagent blank contamination	No	173	3,967	4.36	Representativeness
Metal	Water	Blanks	Method, preparation, or reagent blank contamination	Yes	42	3,967	1.06	Representativeness
Metal	Water	Blanks	Negative bias indicated in the blanks	No	24	3,967	0.60	Representativeness
Metal	Water	Blanks	Negative bias indicated in the blanks	Yes	21	3,967	0.53	Representativeness
Metal	Water	Calculation Errors	Control limits not assigned correctly	No	1	3,967	0.03	N/A
Metal	Water	Calibration	Calibration correlation coefficient did not meet requirements	No	5	3,967	0.13	Accuracy

Table A2.2
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect	No. of Records w/ Noted Observation	Total No. of V&V Records	Percent Observed (%)	PARCC Parameter Affected
Metal	Water	Calibration	Calibration correlation coefficient did not meet requirements	Yes	1	3,967	0.03	Accuracy
Metal	Water	Calibration	Continuing calibration verification criteria were not met	No	5	3,967	0.13	Accuracy
Metal	Water	Calibration	Continuing calibration verification criteria were not met	Yes	6	3,967	0.15	Accuracy
Metal	Water	Documentation Issues	Electronic qualifiers were applied from validation report by hand	No	18	3,967	0.45	N/A
Metal	Water	Documentation Issues	Electronic qualifiers were applied from validation report by hand	Yes	11	3,967	0.28	N/A
Metal	Water	Documentation Issues	Key data fields incorrect	No	16	3,967	0.40	N/A
Metal	Water	Documentation Issues	Key data fields incorrect	Yes	22	3,967	0.55	N/A
Metal	Water	Documentation Issues	Missing deliverables (not required for validation)	No	21	3,967	0.53	N/A
Metal	Water	Documentation Issues	Missing deliverables (not required for validation)	Yes	35	3,967	0.88	N/A
Metal	Water	Documentation Issues	Missing deliverables (required for validation)	No	10	3,967	0.25	Representativeness
Metal	Water	Documentation Issues	Missing deliverables (required for validation)	Yes	17	3,967	0.43	Representativeness
Metal	Water	Documentation Issues	Omissions or errors in data package (not required for validation)	No	62	3,967	1.56	N/A
Metal	Water	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	113	3,967	2.85	N/A
Metal	Water	Documentation Issues	Omissions or errors in data package (required for validation)	No	2	3,967	0.05	Representativeness
Metal	Water	Documentation Issues	Omissions or errors in data package (required for validation)	Yes	2	3,967	0.05	Representativeness
Metal	Water	Documentation Issues	Record added by the validator	No	48	3,967	1.21	N/A
Metal	Water	Documentation Issues	Record added by the validator	Yes	53	3,967	1.34	N/A

Table A2.2
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect	No. of Records w/ Noted Observation	Total No. of V&V Records	Percent Observed (%)	PARCC Parameter Affected
Metal	Water	Documentation Issues	Transcription error	No	126	3,967	3.18	N/A
Metal	Water	Documentation Issues	Transcription error	Yes	21	3,967	0.53	N/A
Metal	Water	Holding Times	Holding times were exceeded	No	6	3,967	0.15	Representativeness
Metal	Water	Holding Times	Holding times were exceeded	Yes	1	3,967	0.03	Representativeness
Metal	Water	Holding Times	Holding times were grossly exceeded	Yes	1	3,967	0.03	Representativeness
Metal	Water	Instrument Set-up	Interference was indicated in the interference check sample	No	3	3,967	0.08	Accuracy
Metal	Water	Instrument Set-up	Interference was indicated in the interference check sample	Yes	11	3,967	0.28	Accuracy
Metal	Water	LCS	CRDL check sample recovery criteria were not met	No	25	3,967	0.63	Accuracy
Metal	Water	LCS	CRDL check sample recovery criteria were not met	Yes	15	3,967	0.38	Accuracy
Metal	Water	LCS	LCS data not submitted by the laboratory	No	1	3,967	0.03	Representativeness
Metal	Water	LCS	LCS recovery criteria were not met	No	1	3,967	0.03	Accuracy
Metal	Water	LCS	LCS recovery criteria were not met	Yes	14	3,967	0.35	Accuracy
Metal	Water	LCS	Low level check sample recovery criteria were not met	No	28	3,967	0.71	Accuracy
Metal	Water	LCS	Low level check sample recovery criteria were not met	Yes	20	3,967	0.50	Accuracy
Metal	Water	LCS	QC sample/analyte (e.g. spike, duplicate, LCS) was not analyzed	No	10	3,967	0.25	Representativeness
Metal	Water	LCS	QC sample/analyte (e.g. spike, duplicate, LCS) was not analyzed	Yes	17	3,967	0.43	Representativeness
Metal	Water	Matrices	Duplicate sample precision criteria were not met	No	10	3,967	0.25	Precision
Metal	Water	Matrices	Duplicate sample precision criteria were not met	Yes	38	3,967	0.96	Precision
Metal	Water	Matrices	LCS/LCSD precision criteria were not met	No	3	3,967	0.08	Precision
Metal	Water	Matrices	LCS/LCSD precision criteria were not met	Yes	7	3,967	0.18	Precision

Table A2.2
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect	No. of Records w/ Noted Observation	Total No. of V&V Records	Percent Observed (%)	PARCC Parameter Affected
Metal	Water	Matrices	MSA calibration correlation coefficient < 0.995	No	1	3,967	0.03	Accuracy
Metal	Water	Matrices	Post-digestion MS did not meet control criteria	No	45	3,967	1.13	Accuracy
Metal	Water	Matrices	Post-digestion MS did not meet control criteria	Yes	4	3,967	0.10	Accuracy
Metal	Water	Matrices	Predigestion MS recovery criteria were not met	No	44	3,967	1.11	Accuracy
Metal	Water	Matrices	Predigestion MS recovery criteria were not met	Yes	66	3,967	1.66	Accuracy
Metal	Water	Matrices	Recovery criteria were not met	Yes	1	3,967	0.03	Accuracy
Metal	Water	Matrices	Serial dilution criteria were not met	No	1	3,967	0.03	Accuracy
Metal	Water	Matrices	Serial dilution criteria were not met	Yes	51	3,967	1.29	Accuracy
Metal	Water	Other	IDL is older than 3 months from date of analysis	No	17	3,967	0.43	Accuracy
Metal	Water	Other	IDL is older than 3 months from date of analysis	Yes	31	3,967	0.78	Accuracy
Metal	Water	Sample Preparation	Samples were not properly preserved in the field	No	8	3,967	0.20	Representativeness
Metal	Water	Sample Preparation	Samples were not properly preserved in the field	Yes	23	3,967	0.58	Representativeness
Metal	Water	Sensitivity	IDL changed due to a significant figure discrepancy	No	7	3,967	0.18	Representativeness
PCB	Soil	Surrogates	Surrogate recovery criteria were not met	No	7	84	8.33	Accuracy
PCB	Water	Documentation Issues	Key data fields incorrect	No	7	28	25.00	N/A
PCB	Water	Surrogates	Surrogate recovery criteria were not met	No	7	28	25.00	Accuracy
Pesticide	Soil	Surrogates	Surrogate recovery criteria were not met	No	20	251	7.97	Accuracy
Pesticide	Water	Calibration	Continuing calibration verification criteria were not met	No	3	92	3.26	Accuracy
Pesticide	Water	Documentation Issues	Key data fields incorrect	No	20	92	21.74	N/A
Pesticide	Water	Documentation Issues	Transcription error	No	4	92	4.35	N/A
Pesticide	Water	Internal Standards	Internal standards did not meet criteria	No	1	92	1.09	Accuracy

Table A2.2
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect	No. of Records w/ Noted Observation	Total No. of V&V Records	Percent Observed (%)	PARCC Parameter Affected
Pesticide	Water	Surrogates	Surrogate recovery criteria were not met	No	21	92	22.83	Accuracy
Radionuclide	Soil	Blanks	Method, preparation, or reagent blank contamination	Yes	11	390	2.82	Representativeness
Radionuclide	Soil	Calculation Errors	Calculation error	Yes	2	390	0.51	N/A
Radionuclide	Soil	Calibration	Continuing calibration verification criteria were not met	Yes	12	390	3.08	Accuracy
Radionuclide	Soil	Documentation Issues	Record added by the validator	Yes	1	390	0.26	N/A
Radionuclide	Soil	Documentation Issues	Results were not included on Data Summary Table	No	4	390	1.03	N/A
Radionuclide	Soil	Documentation Issues	Results were not included on Data Summary Table	Yes	2	390	0.51	N/A
Radionuclide	Soil	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	44	390	11.28	Representativeness
Radionuclide	Soil	Documentation Issues	Transcription error	No	4	390	1.03	N/A
Radionuclide	Soil	Documentation Issues	Transcription error	Yes	22	390	5.64	N/A
Radionuclide	Soil	Instrument Set-up	Detector efficiency did not meet requirements	Yes	4	390	1.03	Accuracy
Radionuclide	Soil	LCS	LCS recovery > +/- 3 sigma	Yes	13	390	3.33	Accuracy
Radionuclide	Soil	LCS	LCS recovery criteria were not met	Yes	1	390	0.26	Accuracy
Radionuclide	Soil	Matrices	Recovery criteria were not met	No	1	390	0.26	Accuracy
Radionuclide	Soil	Matrices	Replicate precision criteria were not met	Yes	7	390	1.79	Precision
Radionuclide	Soil	Matrices	Replicate recovery criteria were not met	Yes	1	390	0.26	Accuracy
Radionuclide	Soil	Other	Lab results not verified due to unsubmitted data	No	2	390	0.51	Representativeness
Radionuclide	Soil	Other	QC sample does not meet method requirements	No	17	390	4.36	Representativeness
Radionuclide	Soil	Other	QC sample does not meet method requirements	Yes	13	390	3.33	Representativeness
Radionuclide	Soil	Other	See hard copy for further explanation	Yes	4	390	1.03	N/A
Radionuclide	Soil	Sensitivity	Incorrect reported activity or MDA	No	5	390	1.28	N/A
Radionuclide	Soil	Sensitivity	Incorrect reported activity or MDA	Yes	1	390	0.26	N/A
Radionuclide	Soil	Sensitivity	MDA exceeded the RDL	Yes	5	390	1.28	Representativeness

Table A2.2
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect	No. of Records w/ Noted Observation	Total No. of V&V Records	Percent Observed (%)	PARCC Parameter Affected
Radionuclide	Soil	Sensitivity	MDA was calculated by reviewer	No	3	390	0.77	N/A
Radionuclide	Soil	Sensitivity	MDA was calculated by reviewer	Yes	63	390	16.15	N/A
Radionuclide	Soil	Sensitivity	Results considered qualitative not quantitative	No	1	390	0.26	Accuracy
Radionuclide	Water	Blanks	Blank correction was not performed	No	5	1,978	0.25	Representativeness
Radionuclide	Water	Blanks	Blank correction was not performed	Yes	3	1,978	0.15	Representativeness
Radionuclide	Water	Blanks	Blank recovery criteria were not met	No	5	1,978	0.25	Representativeness
Radionuclide	Water	Blanks	Blank recovery criteria were not met	Yes	6	1,978	0.30	Representativeness
Radionuclide	Water	Blanks	Method, preparation, or reagent blank contamination	No	20	1,978	1.01	Representativeness
Radionuclide	Water	Blanks	Method, preparation, or reagent blank contamination	Yes	55	1,978	2.78	Representativeness
Radionuclide	Water	Calculation Errors	Calculation error	No	14	1,978	0.71	N/A
Radionuclide	Water	Calculation Errors	Calculation error	Yes	2	1,978	0.10	N/A
Radionuclide	Water	Calibration	Calibration requirements affecting data quality have not been met	No	1	1,978	0.05	Accuracy
Radionuclide	Water	Calibration	Continuing calibration verification criteria were not met	No	11	1,978	0.56	Accuracy
Radionuclide	Water	Calibration	Continuing calibration verification criteria were not met	Yes	70	1,978	3.54	Accuracy
Radionuclide	Water	Documentation Issues	Information missing from case narrative	No	7	1,978	0.35	N/A
Radionuclide	Water	Documentation Issues	Information missing from case narrative	Yes	2	1,978	0.10	N/A
Radionuclide	Water	Documentation Issues	Missing deliverables (not required for validation)	No	6	1,978	0.30	N/A
Radionuclide	Water	Documentation Issues	Missing deliverables (not required for validation)	Yes	4	1,978	0.20	N/A
Radionuclide	Water	Documentation Issues	Missing deliverables (required for validation)	No	15	1,978	0.76	Representativeness
Radionuclide	Water	Documentation Issues	Missing deliverables (required for validation)	Yes	7	1,978	0.35	Representativeness
Radionuclide	Water	Documentation Issues	Omissions or errors in data package (not required for validation)	No	44	1,978	2.22	N/A

Table A2.2
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect	No. of Records w/ Noted Observation	Total No. of V&V Records	Percent Observed (%)	PARCC Parameter Affected
Radionuclide	Water	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	15	1,978	0.76	N/A
Radionuclide	Water	Documentation Issues	Omissions or errors in data package (required for validation)	No	2	1,978	0.10	Representativeness
Radionuclide	Water	Documentation Issues	Record added by the validator	Yes	2	1,978	0.10	N/A
Radionuclide	Water	Documentation Issues	Sufficient documentation not provided by the laboratory	No	1	1,978	0.05	Representativeness
Radionuclide	Water	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	27	1,978	1.37	Representativeness
Radionuclide	Water	Documentation Issues	Transcription error	No	38	1,978	1.92	N/A
Radionuclide	Water	Documentation Issues	Transcription error	Yes	21	1,978	1.06	N/A
Radionuclide	Water	Holding Times	Holding times were exceeded	Yes	4	1,978	0.20	Representativeness
Radionuclide	Water	Holding Times	Holding times were grossly exceeded	No	10	1,978	0.51	Representativeness
Radionuclide	Water	Holding Times	Holding times were grossly exceeded	Yes	9	1,978	0.46	Representativeness
Radionuclide	Water	Instrument Set-up	Resolution criteria were not met	Yes	9	1,978	0.46	Representativeness
Radionuclide	Water	Instrument Set-up	Transformed spectral index external site criteria were not met	No	2	1,978	0.10	Representativeness
Radionuclide	Water	LCS	Expected LCS value not submitted/verifiable	Yes	5	1,978	0.25	Representativeness
Radionuclide	Water	LCS	LCS recovery > +/- 3 sigma	No	26	1,978	1.31	Accuracy
Radionuclide	Water	LCS	LCS recovery > +/- 3 sigma	Yes	32	1,978	1.62	Accuracy
Radionuclide	Water	LCS	LCS recovery criteria were not met	No	5	1,978	0.25	Accuracy
Radionuclide	Water	LCS	LCS recovery criteria were not met	Yes	3	1,978	0.15	Accuracy
Radionuclide	Water	LCS	LCS relative percent error criteria not met	No	15	1,978	0.76	Accuracy
Radionuclide	Water	LCS	LCS relative percent error criteria not met	Yes	39	1,978	1.97	Accuracy
Radionuclide	Water	LCS	QC sample/analyte (e.g. spike, duplicate, LCS) was not analyzed	No	1	1,978	0.05	Representativeness
Radionuclide	Water	LCS	QC sample/analyte (e.g. spike, duplicate, LCS) was not analyzed	Yes	1	1,978	0.05	Representativeness
Radionuclide	Water	Matrices	Duplicate analysis was not performed	No	1	1,978	0.05	Precision

Table A2.2
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect	No. of Records w/ Noted Observation	Total No. of V&V Records	Percent Observed (%)	PARCC Parameter Affected
Radionuclide	Water	Matrices	Duplicate analysis was not performed	Yes	2	1,978	0.10	Precision
Radionuclide	Water	Matrices	Duplicate sample precision criteria were not met	Yes	4	1,978	0.20	Precision
Radionuclide	Water	Matrices	Laboratory duplicate was not analyzed	No	1	1,978	0.05	Precision
Radionuclide	Water	Matrices	Recovery criteria were not met	No	3	1,978	0.15	Accuracy
Radionuclide	Water	Matrices	Recovery criteria were not met	Yes	13	1,978	0.66	Accuracy
Radionuclide	Water	Matrices	Replicate analysis was not performed	Yes	4	1,978	0.20	Precision
Radionuclide	Water	Matrices	Replicate precision criteria were not met	No	6	1,978	0.30	Precision
Radionuclide	Water	Matrices	Replicate precision criteria were not met	Yes	33	1,978	1.67	Precision
Radionuclide	Water	Matrices	Replicate recovery criteria were not met	Yes	1	1,978	0.05	Accuracy
Radionuclide	Water	Other	QC sample does not meet method requirements	No	18	1,978	0.91	Representativeness
Radionuclide	Water	Other	QC sample does not meet method requirements	Yes	10	1,978	0.51	Representativeness
Radionuclide	Water	Other	Sample or control analyses not chemically separated	No	1	1,978	0.05	Representativeness
Radionuclide	Water	Other	Sample or control analyses not chemically separated	Yes	2	1,978	0.10	Representativeness
Radionuclide	Water	Other	See hard copy for further explanation	No	11	1,978	0.56	N/A
Radionuclide	Water	Other	See hard copy for further explanation	Yes	19	1,978	0.96	N/A
Radionuclide	Water	Other	Tracer requirements were not met	No	8	1,978	0.40	Accuracy
Radionuclide	Water	Other	Tracer requirements were not met	Yes	5	1,978	0.25	Accuracy
Radionuclide	Water	Sample Preparation	Samples were not properly preserved in the field	No	19	1,978	0.96	Representativeness
Radionuclide	Water	Sample Preparation	Samples were not properly preserved in the field	Yes	9	1,978	0.46	Representativeness
Radionuclide	Water	Sensitivity	Incorrect reported activity or MDA	No	3	1,978	0.15	N/A
Radionuclide	Water	Sensitivity	Incorrect reported activity or MDA	Yes	2	1,978	0.10	N/A
Radionuclide	Water	Sensitivity	MDA exceeded the RDL	No	4	1,978	0.20	Representativeness
Radionuclide	Water	Sensitivity	MDA exceeded the RDL	Yes	13	1,978	0.66	Representativeness
Radionuclide	Water	Sensitivity	MDA was calculated by reviewer	No	3	1,978	0.15	N/A
Radionuclide	Water	Sensitivity	MDA was calculated by reviewer	Yes	86	1,978	4.35	N/A
SVOC	Soil	Blanks	Method, preparation, or reagent blank contamination	No	1	751	0.13	Representativeness

Table A2.2
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect	No. of Records w/ Noted Observation	Total No. of V&V Records	Percent Observed (%)	PARCC Parameter Affected
SVOC	Soil	Calibration	Continuing calibration verification criteria were not met	No	8	751	1.07	Accuracy
SVOC	Soil	Calibration	Continuing calibration verification criteria were not met	Yes	1	751	0.13	Accuracy
SVOC	Soil	Internal Standards	Internal standards did not meet criteria	No	12	751	1.60	Accuracy
SVOC	Soil	Internal Standards	Internal standards did not meet criteria	Yes	1	751	0.13	Accuracy
SVOC	Water	Blanks	Method, preparation, or reagent blank contamination	No	2	747	0.27	Representativeness
SVOC	Water	Calibration	Continuing calibration verification criteria were not met	No	12	747	1.61	Accuracy
SVOC	Water	Calibration	Independent calibration verification criteria not met	No	1	747	0.13	Accuracy
SVOC	Water	Documentation Issues	Missing deliverables (not required for validation)	No	3	747	0.40	N/A
SVOC	Water	Documentation Issues	Omissions or errors in data package (not required for validation)	No	11	747	1.47	N/A
SVOC	Water	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	1	747	0.13	N/A
SVOC	Water	Documentation Issues	Omissions or errors in data package (required for validation)	No	3	747	0.40	Representativeness
SVOC	Water	Documentation Issues	Transcription error	No	236	747	31.59	N/A
SVOC	Water	Holding Times	Holding times were exceeded	No	12	747	1.61	Representativeness
SVOC	Water	Holding Times	Holding times were exceeded	Yes	1	747	0.13	Representativeness
SVOC	Water	Instrument Set-up	Instrument tune criteria were not met	No	6	747	0.80	Accuracy
SVOC	Water	Internal Standards	Internal standards did not meet criteria	No	23	747	3.08	Accuracy
SVOC	Water	LCS	LCS recovery criteria were not met	No	4	747	0.54	Accuracy
SVOC	Water	Sample Preparation	Samples were not properly preserved in the field	No	2	747	0.27	Representativeness
SVOC	Water	Sample Preparation	Samples were not properly preserved in the field	Yes	1	747	0.13	Representativeness
VOC	Soil	Blanks	Method, preparation, or reagent blank contamination	No	13	1,490	0.87	Representativeness
VOC	Soil	Blanks	Method, preparation, or reagent blank contamination	Yes	26	1,490	1.74	Representativeness

Table A2.2
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect	No. of Records w/ Noted Observation	Total No. of V&V Records	Percent Observed (%)	PARCC Parameter Affected
VOC	Soil	Calibration	Continuing calibration verification criteria were not met	No	56	1,490	3.76	Accuracy
VOC	Soil	Calibration	Continuing calibration verification criteria were not met	Yes	5	1,490	0.34	Accuracy
VOC	Soil	Holding Times	Holding times were exceeded	No	34	1,490	2.28	Representativeness
VOC	Soil	Internal Standards	Internal standards did not meet criteria	No	16	1,490	1.07	Accuracy
VOC	Soil	Internal Standards	Internal standards did not meet criteria	Yes	2	1,490	0.13	Accuracy
VOC	Soil	Surrogates	Surrogate recovery criteria were not met	No	33	1,490	2.21	Accuracy
VOC	Soil	Surrogates	Surrogate recovery criteria were not met	Yes	1	1,490	0.07	Accuracy
VOC	Water	Blanks	Method, preparation, or reagent blank contamination	No	8	2,940	0.27	Representativeness
VOC	Water	Blanks	Method, preparation, or reagent blank contamination	Yes	4	2,940	0.14	Representativeness
VOC	Water	Calibration	Continuing calibration verification criteria were not met	No	22	2,940	0.75	Accuracy
VOC	Water	Calibration	Independent calibration verification criteria not met	Yes	1	2,940	0.03	Accuracy
VOC	Water	Documentation Issues	Missing deliverables (not required for validation)	No	55	2,940	1.87	N/A
VOC	Water	Documentation Issues	Omissions or errors in data package (not required for validation)	No	217	2,940	7.38	N/A
VOC	Water	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	1	2,940	0.03	N/A
VOC	Water	Documentation Issues	Omissions or errors in data package (required for validation)	No	54	2,940	1.84	Representativeness
VOC	Water	Documentation Issues	Sample analysis was not requested	Yes	1	2,940	0.03	N/A
VOC	Water	Documentation Issues	Transcription error	No	19	2,940	0.65	N/A
VOC	Water	Holding Times	Holding times were exceeded	No	178	2,940	6.05	Representativeness
VOC	Water	Holding Times	Holding times were exceeded	Yes	1	2,940	0.03	Representativeness
VOC	Water	Instrument Set-up	Instrument tune criteria were not met	No	109	2,940	3.71	Accuracy
VOC	Water	Instrument Set-up	Instrument tune criteria were not met	Yes	1	2,940	0.03	Accuracy
VOC	Water	Internal Standards	Internal standards did not meet criteria	No	25	2,940	0.85	Accuracy
VOC	Water	LCS	LCS recovery criteria were not met	No	22	2,940	0.75	Accuracy

Table A2.2
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect	No. of Records w/ Noted Observation	Total No. of V&V Records	Percent Observed (%)	PARCC Parameter Affected
VOC	Water	LCS	LCS recovery criteria were not met	Yes	2	2,940	0.07	Accuracy
VOC	Water	Sample Preparation	Samples were not properly preserved in the field	No	55	2,940	1.87	Representativeness
Wet Chem	Soil	Documentation Issues	Transcription error	No	5	35	14.29	N/A
Wet Chem	Soil	Holding Times	Holding times were exceeded	Yes	1	35	2.86	Representativeness
Wet Chem	Soil	Matrices	LCS/LCSD precision criteria were not met	Yes	8	35	22.86	Precision
Wet Chem	Soil	Matrices	Predigestion MS recovery was < 30 percent	Yes	18	35	51.43	Accuracy
Wet Chem	Soil	Other	IDL is older than 3 months from date of analysis	Yes	6	35	17.14	Accuracy
Wet Chem	Soil	Sample Preparation	Samples were not properly preserved in the field	Yes	1	35	2.86	Representativeness
Wet Chem	Water	Blanks	Calibration verification blank contamination	No	3	990	0.30	Representativeness
Wet Chem	Water	Blanks	Method, preparation, or reagent blank contamination	No	1	990	0.10	Representativeness
Wet Chem	Water	Blanks	Negative bias indicated in the blanks	No	1	990	0.10	Representativeness
Wet Chem	Water	Calculation Errors	Control limits not assigned correctly	Yes	2	990	0.20	N/A
Wet Chem	Water	Documentation Issues	Key data fields incorrect	Yes	1	990	0.10	N/A
Wet Chem	Water	Documentation Issues	Missing deliverables (not required for validation)	No	1	990	0.10	N/A
Wet Chem	Water	Documentation Issues	Missing deliverables (not required for validation)	Yes	2	990	0.20	N/A
Wet Chem	Water	Documentation Issues	Missing deliverables (required for validation)	No	1	990	0.10	Representativeness
Wet Chem	Water	Documentation Issues	Missing deliverables (required for validation)	Yes	2	990	0.20	Representativeness
Wet Chem	Water	Documentation Issues	Omissions or errors in data package (not required for validation)	No	12	990	1.21	N/A
Wet Chem	Water	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	27	990	2.73	N/A

Table A2.2
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect	No. of Records w/ Noted Observation	Total No. of V&V Records	Percent Observed (%)	PARCC Parameter Affected
Wet Chem	Water	Documentation Issues	Omissions or errors in data package (required for validation)	No	4	990	0.40	Representativeness
Wet Chem	Water	Documentation Issues	Record added by the validator	No	1	990	0.10	N/A
Wet Chem	Water	Documentation Issues	Transcription error	No	4	990	0.40	N/A
Wet Chem	Water	Documentation Issues	Transcription error	Yes	8	990	0.81	N/A
Wet Chem	Water	Holding Times	Holding times were exceeded	No	3	990	0.30	Representativeness
Wet Chem	Water	Holding Times	Holding times were exceeded	Yes	7	990	0.71	Representativeness
Wet Chem	Water	Holding Times	Holding times were grossly exceeded	No	1	990	0.10	Representativeness
Wet Chem	Water	Holding Times	Holding times were grossly exceeded	Yes	1	990	0.10	Representativeness
Wet Chem	Water	Matrices	Predigestion MS recovery criteria were not met	No	6	990	0.61	Accuracy
Wet Chem	Water	Matrices	Predigestion MS recovery criteria were not met	Yes	17	990	1.72	Accuracy
Wet Chem	Water	Matrices	Predigestion MS recovery was < 30 percent	Yes	1	990	0.10	Accuracy
Wet Chem	Water	Other	Lab results not verified due to unsubmitted data	Yes	2	990	0.20	Representativeness
Wet Chem	Water	Sample Preparation	Preservation requirements were not met by the laboratory	No	1	990	0.10	Representativeness
Wet Chem	Water	Sample Preparation	Preservation requirements were not met by the laboratory	Yes	8	990	0.81	Representativeness
Wet Chem	Water	Sample Preparation	Sample pretreatment or preparation method was incorrect	Yes	1	990	0.10	Representativeness
Wet Chem	Water	Sample Preparation	Samples were not properly preserved in the field	No	4	990	0.40	Representativeness
Wet Chem	Water	Sample Preparation	Samples were not properly preserved in the field	Yes	40	990	4.04	Representativeness

Table A2.3
Summary of Data Estimated or Undetected Due to V&V Determinations

Analyte Group	Matrix	No. of CRA Data Records Qualified	Total No. of V&V CRA Records	Detect	Percent Qualified (%)
Metal	Soil	174	1,397	No	12.46
Metal	Soil	332	1,397	Yes	23.77
Metal	Water	460	3,967	No	11.60
Metal	Water	301	3,967	Yes	7.59
PCB	Soil	7	84	No	8.33
PCB	Water	7	28	No	25.00
Pesticide	Soil	20	251	No	7.97
Pesticide	Water	23	92	No	25.00
Radionuclide	Soil	3	390	No	0.77
Radionuclide	Soil	4	390	Yes	1.03
Radionuclide	Water	16	1,978	No	0.81
Radionuclide	Water	30	1,978	Yes	1.52
SVOC	Soil	21	751	No	2.80
SVOC	Water	51	747	No	6.83
SVOC	Water	1	747	Yes	0.13
VOC	Soil	142	1,490	No	9.53
VOC	Soil	29	1,490	Yes	1.95
VOC	Water	247	2,940	No	8.40
VOC	Water	5	2,940	Yes	0.17
Wet Chem	Soil	19	35	Yes	54.29
Wet Chem	Water	13	990	No	1.31
Wet Chem	Water	32	990	Yes	3.23
	Total	**1,937**	**15,166**		**12.77%**

Table A2.4
Summary of Data Qualified as Undetected Due to Blank Contamination

Analyte Group	Matrix	No. of CRA Records Qualified as Undetected Due to Blank Contaimination	Total No. of CRA Records with Detected Results[a]	Percent Qualified as Undetected
Metal	Soil	52	1,072	4.85
Metal	Water	72	2,025	3.56
Wet Chem	Water	1	770	0.13
	Total	**125**	**3,867**	**3.23%**

[a] As determined by the laboratory prior to V&V.

Table A2.5
Summary of RPDs/DERs of Field Duplicate Analyte Pairs

Analyte Group	Matrix	No. of Duplicates Failing RPD/DER Criteria	Total No. of Duplicate Pairs	Percent Failure (%)	Field Duplicate Frequency (%)
Herbicide	Soil	0	1	0.00	8.33
Metal	Soil	16	141	11.35	10.09
Metal	Water	0	93	0.00	2.05
PCB	Soil	0	7	0.00	8.33
Pesticide	Soil	0	21	0.00	8.33
Radionuclide	Soil	0	30	0.00	6.64
Radionuclide	Water	0	93	0.00	2.34
SVOC	Soil	0	59	0.00	7.82
VOC	Soil	0	72	0.00	4.62
Wet Chem	Soil	0	1	0.00	2.86
Wet Chem	Water	0	17	0.00	1.07

Table A2.6
Summary of Data Rejected During V&V

Analyte Group	Matrix	Total No. of Rejected Records	Total No. of V&V Records	Percent Rejected (%)
Dioxins and Furans	Water	2	13	15.38
Herbicide	Soil	0	13	0.00
Herbicide	Water	6	23	26.09
Metal	Soil	10	1,436	0.70
Metal	Water	75	4,976	1.51
PCB	Soil	0	91	0.00
PCB	Water	0	63	0.00
Pesticide	Soil	1	273	0.37
Pesticide	Water	0	203	0.00
Radionuclide	Soil	35	445	7.87
Radionuclide	Water	135	2,494	5.41
SVOC	Soil	4	815	0.49
SVOC	Water	83	1,431	5.80
VOC	Soil	14	1,674	0.84
VOC	Water	99	3,899	2.54
Wet Chem	Soil	0	35	0.00
Wet Chem	Water	16	1,117	1.43
	Total	**480**	**19,001**	**2.53%**

Table A2.7
Summary of Data Quality Issues Identified by V&V

Analyte Group	Matrix	Categories Description	V&V Observation	Detect	Percent Observed	Percent Qualified U[a]	Percent Qualified J[b]	PARCC Parameter Affected	Impacts Risk Assessment Decisions
Metal	Soil	Matrices	Predigestion MS recovery criteria were not met	Yes	7.80	0.00	7.80	Accuracy	No
Metal	Soil	Matrices	Serial dilution criteria were not met	Yes	7.02	0.00	7.02	Accuracy	No
Metal	Soil	Other	IDL is older than 3 months from date of analysis	Yes	6.23	0.00	0.86	Accuracy	No
PCB	Soil	Surrogates	Surrogate recovery criteria were not met	No	8.33	0.00	8.33	Accuracy	No
PCB	Water	Surrogates	Surrogate recovery criteria were not met	No	25.00	0.00	25.00	Accuracy	No
Pesticide	Soil	Surrogates	Surrogate recovery criteria were not met	No	7.97	0.00	7.97	Accuracy	No
Pesticide	Water	Surrogates	Surrogate recovery criteria were not met	No	22.83	0.00	22.83	Accuracy	No
Radionuclide	Soil	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	11.28	0.00	0.00	Representativeness	No
VOC	Water	Holding Times	Holding times were exceeded	No	6.05	5.31	0.75	Representativeness	No
Wet Chem	Soil	Matrices	LCS/LCSD precision criteria were not met	Yes	22.86	0.00	22.86	Precision	No
Wet Chem	Soil	Matrices	Predigestion MS recovery was < 30 percent	Yes	51.43	0.00	51.43	Accuracy	No
Wet Chem	Soil	Other	IDL is older than 3 months from date of analysis	Yes	17.14	0.00	17.14	Accuracy	No

[a]Defined as validation qualifier codes containing "U"

[b]Defined as validation qualifier codes containing "J", except "UJ"

COMPREHENSIVE RISK ASSESSMENT

LOWER WALNUT DRAINAGE EXPOSURE UNIT

VOLUME 8: ATTACHMENT 3

Statistical Analyses and Professional Judgment

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

µg/kg	microgram per kilogram
AL	action level
CDH	Colorado Department of Health
CDPHE	Colorado Department of Public Health and Environment
COC	contaminant of concern
CRA	Comprehensive Risk Assessment
DOE	U.S. Department of Energy
DQA	Data Quality Assessment
ECOI	ecological contaminant of interest
EcoSSL	Ecological Soil Screening Level
ECOPC	ecological contaminant of potential concern
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERA	Ecological Risk Assessment
ESL	ecological screening level
EU	Exposure Unit
GIS	Geographical Information System
HEPA	High-Efficiency Particulate Air
HHRA	Human Health Risk Assessment
HRR	Historical Release Report
IA	Industrial Area
IAEU	Industrial Area Exposure Unit
IHSS	Individual Hazardous Substance Site
LWOEU	Lower Woman Drainage Exposure Unit

LWNEU	Lower Walnut Drainage Exposure Unit
MDC	maximum detected concentration
mg/kg	milligrams per kilogram
NCP	National Contingency Plan
NFA	No Further Action
NNEU	No Name Gulch Exposure Drainage Unit
NOAEL	no observed adverse effect level
OU	Operable Unit
PAC	Potential Area of Concern
PCB	polychlorinated biphenyl
pCi/g	picocuries per gram
PCOC	potential contaminant of concern
PDSR	Pre-Demolition Survey Report
PMJM	Preble's meadow jumping mouse
PRG	preliminary remediation goal
RCEU	Rock Creek Drainage Exposure Unit
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RI/FS	Remedial Investigation/Feasibility Study
RLCR	Reconnaissance-Level Characterization Reports
tESL	threshold ESL
UBC	Under Building Contamination
UCL	upper confidence limit
UTL	upper tolerance limit
WRS	Wilcoxon Rank Sum

WRW wildlife refuge worker

1.0 INTRODUCTION

This attachment presents the results for the statistical analyses and professional judgment evaluation used to select human health contaminants of concern (COCs) as part of the Human Health Risk Assessment (HHRA) and ecological contaminants of potential concern (ECOPCs) as part of the Ecological Risk Assessment (ERA) for the Lower Walnut Drainage Exposure Unit (EU) (LWNEU) at the Rocky Flats Environmental Technology Site (RFETS). The methods used to perform the statistical analysis and develop the professional judgment sections are described in Sections 2.2.5 (HHRA) and 2.3.4 (ERA) of Appendix A, Volume 2 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation (RI)/Corrective Measures Study (CMS)-Feasibility Study (FS) Report (hereafter referred to as the RI/FS Report) and follow the Final Comprehensive Risk Assessment (CRA) Work Plan and Methodology (DOE 2005).

2.0 RESULTS OF STATISTICAL COMPARISONS TO BACKGROUND FOR THE LOWER WALNUT DRAINAGE EXPOSURE UNIT

The results of the statistical background comparisons for inorganic and radionuclide potential contaminants of concern (PCOCs) and ecological contaminants of interest (ECOIs) in surface soil/surface sediment, subsurface soil/subsurface sediment, surface soil, and subsurface soil samples collected from the LWNEU are presented in this section. Box plots are provided for analytes that were carried forward into the statistical comparison step and are presented in Figures A3.2.1 to A3.2.24.[1] The box plots display several reference points: 1) the line inside the box is the median; 2) the lower edge of the box is the 25th percentile; 3) the upper edge of the box is the 75th percentile; 4) the upper lines (called whiskers) are drawn to the greatest value that is less than or equal to 1.5 times the inter-quartile range (the inter-quartile range is between the 75th and 25th percentiles); 5) the lower whiskers are drawn to the lowest value that is greater than or equal to 1.5 times the inter-quartile range; and 6) solid circles are data points greater or less than the whiskers.

PCOCs with concentrations in the LWNEU that are statistically greater than background (or if background comparisons were not performed) are carried through to the professional judgment step of the COC/ECOPC selection processes. ECOIs (for non-Preble's meadow jumping mouse [PMJM] receptors) with concentrations in the LWNEU that are statistically greater than background (or if background comparisons are not

[1] Statistical background comparisons are not performed for analytes if: 1) the background concentrations are nondetections; 2) background data are unavailable; 3) the analyte has low detection frequency in the LWNEU or background data set (less than 20 percent); or 4) the analyte is an organic compound. Box plots are not provided for these analytes. However, these analytes are carried forward into the professional judgment evaluation.

performed) are carried through to the exposure point concentration (EPC)-to-threshold ecological screening level (ESL) comparison step of the ECOPC selection processes.

PCOCs and ECOIs with concentrations that are not statistically greater than background are not identified as COCs/ECOPCs and are not evaluated further.

2.1 Surface Soil/Surface Sediment Data Used in the HHRA

For the LWNEU surface soil/surface sediment data set, the maximum detected concentrations (MDCs) for iron and manganese exceeded the wildlife refuge worker (WRW) preliminary remediation goals (PRGs), but their upper confidence limits (UCLs) on the mean concentration for the site data set did not exceed the PRG. Consequently, iron and manganese were not evaluated further.

The MDCs and UCLs for arsenic, cesium-134, cesium-137, and radium-228 exceed the PRGs for the LWNEU data set and were carried forward into the statistical background comparison step. The results of the statistical comparison of the LWNEU surface soil/surface sediment data to background data for these four analytes are presented in Table A3.2.1, while the summary statistics for background and LWNEU surface soil/surface sediment data are shown in Table A3.2.2.

The results of the statistical comparisons of the LWNEU surface soil/surface sediment data to background data indicate the following:

Analytes Statistically Greater than Background at the 0.1 Significance Level

- Arsenic

Analytes Not Statistically Greater than Background at the 0.1 Significance Level

- Cesium-134
- Cesium-137

Background Comparison Not Performed

- Radium-228

2.2 Subsurface Soil/Subsurface Sediment Data Used in the HHRA

The MDC and UCL for radium-228 exceed the PRG for the LWNEU data set and radium-228 was carried forward into the statistical background comparison step. The results of the statistical comparison of the LWNEU subsurface soil/subsurface sediment data to background data for radium-228 are presented in Table A3.2.3, while the summary statistics for background and LWNEU subsurface soil/subsurface sediment data are shown in Table A3.2.4.

The results of the statistical comparisons of the LWNEU subsurface soil/subsurface sediment data to background data indicate the following:

Analytes Statistically Greater than Background at the 0.1 Significance Level

- None

Analytes Not Statistically Greater than Background at the 0.1 Significance Level

- Radium-228

Background Comparison Not Performed[1]

- None

2.3 Surface Soil Data Used in the ERA (Non-PMJM Receptors)

For the LWNEU surface soil data set, the MDCs for aluminum, antimony, arsenic, barium, boron, cadmium, chromium, copper, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, tin, vanadium, and zinc exceeded a non-PMJM ESL and, consequently, these analytes were carried forward into the statistical background comparison step. The statistical background comparison is not performed for organics, so 4,4'-DDT was carried forward in the EPC versus tESL comparison step. The results of the statistical comparison of the LWNEU surface soil data to background data are presented in Table A3.2.5 and the summary statistics for background and LWNEU surface soil data are shown in Table A3.2.6.

The results of the statistical comparisons of the LWNEU surface soil to background data indicate the following:

Analytes Statistically Greater than Background at the 0.1 Significance Level

- Aluminum
- Barium
- Chromium
- Lithium
- Nickel
- Vanadium
- Zinc

Analytes Not Statistically Greater than Background at the 0.1 Significance Level

- Arsenic
- Cadmium
- Copper
- Lead
- Manganese
- Mercury

Background Comparison Not Performed[1]

- Antimony
- Boron
- Molybdenum
- Selenium
- Tin

2.4 Surface Soil Data Used in the ERA (PMJM Receptors)

The MDCs for arsenic, chromium, manganese, nickel, vanadium, and zinc exceed the ESLs for the PMJM receptor for the LWNEU surface soil data set (i.e., samples within the PMJM habitat areas) and were carried forward into the background comparison step. The results of the statistical comparison of the LWNEU surface soil data to background data are presented in Table A3.2.7 and the summary statistics for background and LWNEU surface soil data are shown in Table A3.2.8.

The results of the statistical comparisons of the LWNEU surface soil for PMJM receptors to background data indicate the following:

Analytes Statistically Greater than Background at the 0.1 Significance Level

- Chromium
- Nickel

Analytes Not Statistically Greater than Background at the 0.1 Significance Level

- Arsenic

- Manganese
- Vanadium
- Zinc

Background Comparison Not Performed[1]

- None

2.5 Subsurface Soil Data Used in the ERA

The MDC for arsenic exceeded an ESL for burrowing receptors for the LWNEU subsurface soil data set, and was carried forward into the statistical background comparison. The results of the statistical comparison of the LWNEU subsurface soil data to background data are presented in Table A3.2.9 and the summary statistics for background and LWNEU surface soil data are shown in Table A3.2.10.

The results of the statistical comparisons of the LWNEU subsurface soil for burrowing receptors to background data indicate the following:

Analytes Statistically Greater than Background at the 0.1 Significance Level

- Arsenic

Analytes Not Statistically Greater than Background at the 0.1 Significance Level

- None

Background Comparison Not Performed[1]

- None

3.0 UPPER-BOUND EXPOSURE POINT CONCENTRATION COMPARISON TO LIMITING ECOLOGICAL SCREENING LEVELS

ECOIs in surface soil and subsurface soil with concentrations that are statistically greater than background (or if background comparisons were not performed) are evaluated further by comparing the EPC concentrations to the threshold ESLs (tESLs). The upper-bound EPCs are the 95 percent UCL of the 90th percentile [upper tolerance limit (UTL)] for small home-range receptors, the UCL for large home-range receptors, or the MDC in the event that the UCL or UTL is greater than the MDC.

ECOIs in surface soil for PMJM receptors are not screened against tESLs. They are carried forward to the professional judgment evaluation.

3.1 ECOIs in Surface Soil (Non-PMJM)

Of the 13 ECOIs (aluminum, antimony, barium, boron, chromium, lithium, molybdenum, nickel, selenium, tin, vanadium, zinc and 4,4'-DDT) whose concentrations were considered to be statistically greater than background only barium as found to have a upper-bound EPC lower than the tESLs. Therefore, barium was not carried forward into the professional judgment step.

The other 12 ECOIs (aluminum, antimony, boron, chromium, lithium, molybdenum, nickel, selenium, tin, vanadium, zinc, and 4,4'-DDT) were found to have upper-bound EPCs greater than the tESLs. These 12 ECOIs are evaluated in the professional judgment evaluation screening step (Section 4.0).

3.2 ECOIs in Surface Soil (PMJM)

ECOIs in surface soil for PMJM receptors are not screened against tESLs. They are carried forward to the professional judgment evaluation. Therefore, chromium and nickel are carried forward into the professional judgment step.

3.3 ECOIs in Subsurface Soil

Arsenic was found to be statistically greater than background and above an ESL in accordance with the ECOPC selection process. However, arsenic was not found to have upper-bound EPCs greater than the tESLs and was not carried forward into the professional judgment step.

4.0 PROFESSIONAL JUDGMENT

This section presents the results of the professional judgment step of the COC and ECOPC selection processes for the HHRA and ERA, respectively. Based on the weight of evidence evaluated in the professional judgment step, PCOCs and ECOIs are either included for further evaluation as COCs/ECOPCs in the risk characterization step, or excluded from further evaluation.

The professional judgment evaluation takes into account the following lines of evidence: process knowledge, spatial trends, pattern recognition[2], comparison to RFETS

[2] The pattern recognition evaluation includes the use of probability plots. If two or more distinct populations are evident in the probability plot, this suggests that one or more local releases may have occurred. Conversely, if only one distinct low-concentration population is defined, likely representing a background population, a local release may or may not have occurred. Similar to all statistical methods, the probability plot has limitations in cases where there is inadequate sampling and the magnitude of the release is relatively small. Thus, absence of two clear populations in the probability plots is consistent with, but not definitive proof of, the hypothesis that no releases have occurred. However, if a release has occurred within the sampled area and has been included in the samples, then the elemental concentrations

background and regional background data sets (see Table A3.4.1 for a summary of regional background data)[3], and risk potential. For PCOCs or ECOIs where the process knowledge and/or spatial trends indicate that the presence of the analyte in the EU may be a result of historical site-related activities, the professional judgment discussion includes only two of the lines of evidence listed above, and it is concluded that these analytes are COCs/ECOPCs and are carried forward into risk characterization. For the other PCOCs and ECOIs that are evaluated in the professional judgment step, each of the lines of evidence listed above are included in the discussion.

For metals, Appendix A, Volume 2, Attachment 8, of the RI/FS report provides the details of the process knowledge and spatial trend evaluations. The conclusions from these evaluations are noted in this attachment.

The following PCOCs/ECOIs are evaluated further in the professional judgment step for LWNEU:

- Surface soil/surface sediment (HHRA)
  - Arsenic
  - Radium-228
- Surface soil for non-PMJM receptors (ERA)
  - Aluminum
  - Antimony
  - Boron
  - Chromium
  - Lithium
  - Molybdenum
  - Nickel
  - Selenium
  - Tin

associated with that release are either within the background concentration range or the entire sampled population represents a release, a highly unlikely probability.

[3] The regional background data set for Colorado and the bordering states was extracted from data for the western United States (Shacklette and Boerngen 1984), and is composed of data from Colorado as well as Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Utah, and Wyoming. Although the Colorado and bordering states background data set is not specific to Colorado's Front Range, it is useful for the professional judgment evaluation in the absence of a robust data set for the Front Range. Colorado's Front Range has highly variable terrain that changes elevation over short distances. Consequently, numerous soil types and geologic materials are present at RFETS, and the data set for Colorado and bordering states provides regional benchmarks for naturally-occurring metals in soil. The comparison of RFETS's soil data to these regional benchmarks is only performed for non-PMJM professional judgment because the PMJM habitat is restricted to the front range of Colorado.

  - Vanadium
  - Zinc
  - 4,4'-DDT
- Surface soil for PMJM receptors (ERA)
  - Chromium
  - Nickel

The following sections provide the professional judgment evaluations, by analyte and then by medium, for the PCOCs/ECOIs listed above.

4.1 Aluminum

Aluminum has an EPC in surface soil (for non-PMJM receptors) greater than the tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if aluminum should be retained for risk characterization are summarized below.

4.1.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge suggests aluminum may be a present in RFETS soils as a result of historical site-related activities because of large aluminum metal inventory and presence of aluminum in waste generated during former operations. However, site-related activities occurred in the former Industrial Area, which is remote from LWNEU.

4.1.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that aluminum concentrations in LWNEU surface soil reflect variations in naturally occurring aluminum.

4.1.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for the natural log transformed data set for aluminum (Figure A3.4.1) indicates a horizontal step that projects off the background line, which does not indicate a single background population.

4.1.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Aluminum was detected at all 22 sampling locations within LWNEU, but the MDC was lower than background MDC. Aluminum concentrations in surface soil at LWNEU range from 7,460 to 17,000 milligrams per kilogram (mg/kg), with a mean concentration of 11,912 mg/kg and a standard deviation of 2,424 mg/kg (Table A3.2.6). Background aluminum concentrations range from 4,050 to 17,100 mg/kg, with a mean concentration of 10,203 mg/kg and a standard deviation of 3,256 mg/kg. The ranges of the LWNEU and background data sets significantly overlap and the LWNEU aluminum MDC does not exceed the site background MDC.

In addition to aluminum MDC being lower than the site background MDC, aluminum concentrations at the LWNEU are well within the range of reported literature values. Aluminum concentrations reported in surface soil samples at the LWNEU are well within the range for aluminum in soils of Colorado and the bordering states, which range from 5,000 to 100,000 mg/kg, with mean concentration of 50,800 mg/kg and a standard deviation of 23,500 mg/kg (Table A3.4.1).

4.1.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The MDC for aluminum in the LWNEU (17,000 mg/kg) exceeds the no observed adverse effect level (NOAEL) ESL for only one receptor group, terrestrial plants (50 mg/kg). However, U.S. Environmental Protection Agency (EPA) Ecological Soil Screening Level (EcoSSL) guidance (EPA 2003) for aluminum recommends that aluminum not be considered an ECOPC for soils at sites where the soil pH exceeds 5.5 due to its limited bioavailability in non-acidic soils. The average pH value for RFETS surface soils is 8.2.

Aluminum concentrations in the LWNEU show a distribution similar to sitewide background concentrations and there are no historical records of a source area in the LWNEU. Therefore, it is unlikely that the aluminum concentrations in surface soil within the LWNEU could represent potential risk concerns for wildlife populations.

4.1.6 Conclusion

Review of process knowledge indicates that aluminum is unlikely to be present in LWNEU soils as a result of historical site-related activities; the weight of evidence presented above shows that aluminum concentrations in LWNEU surface soil (non-PMJM receptors) have a spatial distribution indicative of naturally occurring aluminum, are well within regional background levels, and are unlikely to result in risk concerns for wildlife populations. Although the log-probability plot does not indicate the presence of a single background population, aluminum is not considered an ECOPC in surface soil for the LWNEU and, therefore, is not further evaluated quantitatively.

4.2 Antimony

Antimony has an EPC in surface soil (for non-PMJM receptors) greater than the tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if antimony should be retained for risk characterization are summarized below.

4.2.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates antimony is unlikely to be present in LWNEU soil as a result of historical site-related activities.

4.2.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that antimony concentrations in LWNEU surface soil reflect variations in naturally occurring antimony.

4.2.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for the natural log transformed data set for antimony (Figure A3.4.2) contains many nondetected concentrations and it is therefore difficult to perform a definitive evaluation. Also, a total of 14 samples is generally too small a population to estimate a background population.

4.2.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Antimony was detected in four of the 14 surface soil samples collected in the LWNEU. Detected antimony concentrations at the LWNEU range from 0.49 to 1.0 mg/kg, with a mean concentration of 2.10 mg/kg and a standard deviation of 2.87 mg/kg (Table A3.2.6). Reported detection limits range from 0.31 to 13.6 mg/kg. None of the background antimony sample results were detects; detection limits varied from 0.38 to 0.94 mg/kg.

The reported range of detected antimony concentrations in surface soils of Colorado and the bordering states range from 1.0 to 2.5 mg/kg, with an arithmetic mean of 0.65 mg/kg (Table A3.4.1). Antimony concentrations reported in surface soil samples at the LWNEU (0.49 to 1.0 mg/kg) are well within this lower range for soils in Colorado and bordering states.

4.2.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The antimony MDC of 1.0 mg/kg exceeds the ESL for the insectivorous deer mouse (0.905 mg/kg). The ESLs for all other non-PMJM receptors were greater than the LWNEU antimony MDC and range from 3.85 to 138 mg/kg. The MDC also exceeds the mammalian Eco-SSL of 0.27 mg/kg for antimony (EPA 2005a). No Eco-SSL is currently available for plants.

4.2.6 Conclusion

Although the log-probability plot is inconclusive with regard to the presence of a single background population, the weight of evidence presented above shows that antimony concentrations in surface soil in the LWNEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations. Additionally, there is no evidence of a release from potential sources inside or outside the EU that would impact antimony concentrations in surface soil. The one historical IHSS located within the LWNEU is associated with sediments in the Flume Pond and not surface soil. In addition, antimony was not detected at concentrations that are likely to cause risk to ecological receptor populations. Antimony is not considered an ECOPC in surface soil for the LWNEU and is not further evaluated quantitatively.

4.3 Arsenic

Arsenic has concentrations statistically greater than background in surface soil/surface sediment and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if arsenic should be retained for risk characterization are summarized below.

4.3.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates arsenic is unlikely to be present in LWNEU soil as a result of historical site-related activities.

4.3.2 Evaluation of Spatial Trends

Surface Soil/ Surface Sediment

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that arsenic concentrations in LWNEU surface soil/surface sediment reflect variations in naturally occurring arsenic.

4.3.3 Pattern Recognition

Surface Soil/Surface Sediment

The probability plot for the natural log-transformed data set for arsenic in combined in surface soil and surface sediment within LWNEU (Figure A3.4.3) suggests that arsenic concentrations form a single background population. One sample (SS20032.WC) which has the lowest arsenic concentration (2.2 mg/kg) falls below the background line probably reflecting the somewhat minor number of samples with arsenic concentrations below about 3.0 mg/kg in the data set.

4.3.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil/Surface Sediment

Arsenic was detected in each of the 25 surface soil/surface sediment samples collected in the LWNEU. Arsenic concentrations in surface soil/surface sediment at the LWNEU range from 2.2 to 9.4 mg/kg, with a mean concentration of 5.45 mg/kg and a standard deviation of 1.56 mg/kg. Arsenic concentrations in the background data set range from 0.270 to 9.60 mg/kg, with a mean concentration of 3.42 mg/kg and a standard deviation of 2.55 mg/kg (Table A3.2.2). The ranges of the LWNEU and background data sets overlap, and the LWNEU surface soil/surface sediment arsenic MDC does not exceed the site background MDC.

Arsenic concentrations reported in surface soil samples at the LWNEU are well within the range for arsenic in soils of Colorado and the bordering states, which range from 1.22 to 97 mg/kg, with a mean concentration of 6.9 mg/kg and a standard deviation of 7.64 mg/kg (Table A3.4.1).

4.3.5 Risk Potential for HHRA

Surface Soil/Surface Sediment

The LWNEU arsenic MDC for surface soil/surface sediment is 9.40 mg/kg and the UCL is 5.79 mg/kg. Although the UCL of 5.79 mg/kg is slightly more than two times greater than the PRG (2.41 mg/kg), the LWNEU surface soil/surface sediment arsenic MDC of 9.40 mg/kg is less than the site background MDC of 9.60 mg/kg. Because the PRG is based on an excess carcinogenic risk of 1E-06, the cancer risk based on the UCL concentration is less than 4E-06, and is well within the National Contingency Plan (NCP) risk range of 1E-06 to 1E-04. The background UCL for arsenic in surface soil/surface sediment is 4.03 mg/kg (Appendix A, Attachment 9 of the RI/FS Report), which equates to a cancer risk of 2E-06. Therefore, the excess cancer risks to the WRW from exposure to arsenic in surface soil/surface sediment in the LWNEU are similar to background risks.

4.3.6 Conclusion

The weight of evidence presented above shows that arsenic concentrations in LWNEU surface soil/surface sediment are not likely to be a result of historical site-related activities based on process knowledge, the spatial distribution trend and the single data population indicative of naturally occurring arsenic. In addition, the MDC for LWNEU arsenic in surface soil and surface sediment does not exceed the background MDC. Arsenic is not considered COC in surface soil/surface sediment for the LWNEU. Therefore, arsenic is not further evaluated quantitatively.

4.4 Boron

For boron in surface soil, a statistical comparison between LWNEU and RFETS background data could not be performed because RFETS background surface soil samples were not analyzed for boron. Boron has an EPC in surface soil (for non-PMJM receptors) greater than the tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if boron should be retained for risk characterization are summarized below.

4.4.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates boron is unlikely to be present in RFETS soil as a result of historical site-related activities.

4.4.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that boron concentrations in LWNEU surface soil reflect variations in naturally occurring boron.

4.4.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for the natural log-transformed data set for boron (Figure A3.4.4) indicates the presence of a single background population.

4.4.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

RFETS background data were not collected for boron. However, the reported range for boron in surface soil within Colorado and the bordering states is 20 to 150 mg/kg, with a mean concentration of 27.9 mg/kg and a standard deviation of 19.7 mg/kg

(Table A3.4.1). Boron concentrations reported in surface soil samples at the LWNEU ranged from 2.75 to 8.40 mg/kg, with a mean concentration of 4.89 mg/kg and a standard deviation of 1.43 mg/kg (Table A3.2.6). The range of boron concentrations in surface soil at the LWNEU are well within the range for boron in soils of Colorado and the bordering states.

4.4.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The MDC for boron in the LWNEU (8.4 mg/kg) exceeds the NOAEL ESL for only one receptor group, terrestrial plants (0.5 mg/kg). All other NOAEL ESLs were greater than the MDC and ranged from 30 to 6,070 mg/kg. Site-specific background data for boron were not available, but the MDC of 8.40 did not exceed the low end (20 mg/kg) of the background range presented in Shacklette and Boerngen (1984). This indicates the terrestrial plant NOAEL ESL (0.5 mg/kg) is well below expected background concentrations, and MDCs above the NOAEL ESL are not likely to be indicative of site-related risk to the terrestrial plant community in the LWNEU. Kabata-Pendias and Pendias (1992) indicate soil with boron concentrations equal to 0.3 mg/kg is critically deficient in boron, and effects on plant reproduction would be expected. Additionally, the summary of boron toxicity in Efroymson et al. (1997) notes that the source of the 0.5-mg/kg NOAEL ESL indicates boron was toxic when added at 0.5 mg/kg to soil, but gives no indication of the boron concentration in the baseline soil before the addition. The confidence placed by Efroymson et al. (1997) was low. No boron Eco-SSLs are currently available.

4.4.6 Conclusion

The weight of evidence presented above shows that boron concentrations in LWNEU surface soil (non-PMJM receptors) are unlikely to be a result of historical site-related activities based on process knowledge, and that the spatial distribution trend and the single data population are indicative of naturally occurring boron. In addition, LWNEU surface soil concentrations for boron are well within regional background levels and are unlikely to result in risk concerns for wildlife populations. Boron is not considered an ECOPC in surface soil for the LWNEU and, therefore, is not further evaluated quantitatively.

4.5 Chromium

Chromium had an upper-bound exposure point concentration (EPC) in surface soil (for non-PMJM receptors) greater than the limiting threshold ecological screening level (tESL) so was carried forward to the professional judgment step per the CRA methodology. In addition, chromium in surface soil (for PMJM receptors) had concentrations statistically greater than background so was carried forward to the professional judgment step. The lines of evidence used to determine if chromium should be retained as an ECOPC are summarized below.

4.5.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for chromium to have been released into RFETS soil because of the moderate chromium metal inventory and presence of chromium in waste generated during former operations. Spills of chromium have occurred at RFETS. However, the historical sources of chromium are in and near the former Industrial Area, which is remote from LWNEU. Therefore, chromium is unlikely to be present in LWNEU soil as of historic site-related activities.

4.5.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that chromium concentrations in LWNEU surface soil reflect variations in naturally occurring chromium.

Surface Soil (PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that chromium concentrations in PMJM habitat surface soil in LWNEU reflect variations in naturally occurring chromium.

4.5.3 Pattern Recognition

Surface Soil (Non-PMJM and PMJM))

The probability plot for the natural log transformed data set for chromium (Figure A3.4.5) indicates two horizontal steps, which does not indicate a single background population.

4.5.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Chromium concentrations in the 22 surface soil samples at the LWNEU for non-PMJM habitats range from 7.92 to 21.0 mg/kg, with a mean concentration of 13.4 mg/kg and a standard deviation of 2.97 mg/kg (Table A3.2.6). Background concentrations of chromium range from 5.5 to 16.9 mg/kg, with a mean concentration of 11.2 mg/kg and a standard deviation of 2.78 mg/kg (Table A3.2.6).

The reported background concentrations for chromium in surface soils of Colorado and bordering states range from 3 to 500 mg/kg, with an arithmetic mean of 48 mg/kg (Table A3.4.1). Chromium concentrations reported in surface soil samples at the LWNEU (7.9 to 21.0 mg/kg) are well within this range.

Surface Soil (PMJM)

Chromium concentrations in nine surface soil samples at the LWNEU for PMJM habitats range from 7.92 to 21.0 mg/kg, with a mean concentration of 13.1 mg/kg and a standard deviation of 3.68 mg/kg (Table A3.2.8). Background concentrations of chromium range from 5.5 to 16.9 mg/kg, with a mean concentration of 11.2 mg/kg and a standard deviation of 2.78 mg/kg (Table A3.2.8).

4.5.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for chromium in the LWNEU (19.0 kg/kg) exceeds the NOAEL ESLs for five receptor groups, terrestrial invertebrates (0.4 mg/kg), terrestrial plants (1.0 mg/kg), insectivorous mourning dove (1.34 mg/kg), American kestrel (14.0 mg/kg), and insectivore deer mouse (15.9 mg/kg). All of these ESLs are less than the maximum detected concentration in background surface soils (16.9 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 25.0 to 4,173.0 mg/kg. The UTL of 19 mg/kg was also less than the avian Eco-SSL for chromium (III) of 26 mg/kg, the mammalian Eco-SSLs for chromium III (34 mg/kg) and chromium (VI) (81 mg/kg) (EPA 2005b). No chromium Eco-SSLs are currently available for plants, invertebrates and birds (chromium (VI) only).

Surface Soil (PMJM)

The MDC for chromium in the LWNEU (21.0 mg/kg) exceeds the NOAEL ESL for PMJM (19.3). The chromium ESL is based on toxicity to hexavalent chromium, of which is likely to represent only a small fraction of the total chromium detected in soils. The PMJM ESL for trivalent chromium is equal to 16,100 mg/kg. This indicates that the ESL based on hexavalent chromium may be overly conservative for use in assessing risk to the PMJM.

4.5.6 Conclusion

The weight of evidence presented above shows that chromium concentrations in LWNEU surface soil (PMJM and non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge, a spatial distribution that suggests chromium is naturally occurring, and LWNEU concentrations that are well within regional background levels. Although the log-probability plot for chromium does not suggests the presence of a single background population, chromium is not considered an ECOPC in surface soil for the LWNEU and, therefore, is not further evaluated quantitatively.

4.6 4,4'-DDT

4,4'-DDT exceeded NOAEL ESLs in surface soil for non-PMJM so was carried forward to the professional judgment step. The lines of evidence used to determine if 4,4'-DDT should be retained as an ECOPC are summarized below.

4.6.1 Summary of Process Knowledge

Based on a review of site historical information, it is highly unlikely that there were releases of 4,4'-DDT to the environment. 4,4'-DDT was identified in the ChemRisk Task 1 report but was not carried forward as a chemical of concern. The historical inventory for 4,4'-DDT in 1988 was only 0.001 kg. There was no inventory for this chemical in 1974 (CDH, 1991).

4.6.2 Summary of Spatial Trends

Surface Soil (Non-PMJM)

Figure A3.4.6 shows that, of the four samples collected within LWNEU, 4,4'-DDT was detected in only one location at a concentration of 26.0 µg/kg. In the adjacent Windblown area, there are 40 sample results for 4,4'-DDT and none showed a detection. Also, there are no detections of 4,4'-DDT in stream sediments in North Walnut Creek, South Walnut Creek, or McKay Ditch (DOE, 1996).

4.6.3 Conclusion

Although 4,4'-DDT is not associated with site activities in the LWNEU and it was detected in only one of four sampling locations, a decision could not be made whether the single detected concentration in the samples collected from the LWNEU is significantly elevated compared to background because the background comparison is not performed for organics. Because the single 4,4'-DDT detected concentration of 26.0 µg/kg exceeded two NOAEL ESLs, insectivorous mourning dove (1.20 µg/kg) and American kestrel (3.34 µg/kg), as a conservative measure, 4,4'-DDT was identified as an ECOPC and carried forward into risk characterization.

4.7 Lithium

Lithium had an upper-bound EPC in surface soil (for non-PMJM receptors) greater than the tESL so was carried forward to the professional judgment step. The lines of evidence used to determine if lithium should be retained as an ECOPC are summarized below.

4.7.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for lithium to have been released into RFETS soil because of the moderate lithium metal inventory and presence of lithium in waste

generated during former operations. However, these historical sources are remote from LWNEU.

4.7.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the analysis of spatial trends for surface soil indicates that lithium concentrations in surface soil reflect variations in naturally occurring lithium.

4.7.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for the natural log-transformed data set for lithium in surface soil within LWNEU (Figure A3.4.7) may represent a single background population. However there are insufficient samples containing more than 12 mg/kg lithium concentrations to document that the background population extends above 12 mg/kg. Only two samples (04F1248-002 and 02D0644-004) contain lithium concentrations above 12 mg/kg (13.1 and 16.0 mg/kg, respectively).

4.7.4 Comparison to RFETS Background and Other Background Data Sets

Lithium was detected in 100 percent of the 22 surface soil samples collected at the LWNEU and range from 4.80 to 16.0 mg/kg, with a mean concentration of 9.86 and a standard deviation of 2.54 mg/kg (Table A3.2.6). Background concentrations of lithium range from 4.80 to 11.6 mg/kg, with a mean of 7.66 mg/kg and a standard deviation of 1.89 mg/kg (Table A3.2.6). There is overlapping between the LWNEU data set and the site background data set indicating that the lithium concentrations within LWNEU represent natural variations in soil.

The reported range for lithium in surface soils in Colorado and the bordering states is 5 to 130 mg/kg, with an arithmetic mean of 25.3 mg/kg and a standard deviation of 14.4 mg/kg (Table A3.4.1). Lithium concentrations reported in surface soil samples at the LWNEU (4.80 to 16.0 mg/kg) are well within this range.

4.7.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The lithium MDC (16 mg/kg) exceeds the NOAEL ESL for only one receptor, terrestrial plants (2 mg/kg), which is lower than the minimum detection of lithium in background surface soil. None of the NOAEL ESLs for mammalian receptors (both non-PMJM and PMJM) are exceeded by the LWNEU surface soil lithium MDC. NOAEL ESLs were not available for avian receptors due to lack of toxicity information. The authors of the document from which the lithium NOAEL ESL was selected (Efroymson et al. 1997b)

placed a low confidence rating on the value. Other studies reported in Efroymson et al. (1997b) cited no observed adverse effects at 25 mg/kg, which is greater than the MDC. Lithium concentrations greater than the background in the LWNEU are most likely due to local variations in natural sources and are below available ESLs for vertebrate receptors. Only a highly conservative and uncertain ESL for terrestrial plants was exceeded. No lithium Eco-SSLs are currently available.

4.7.6 Conclusion

Process knowledge indicates lithium was present in the metals inventory but unlikely to be found in soils at LWNEU as a result of historical site-related activities. The weight of evidence presented above shows that lithium concentrations in LWNEU surface soil (non-PMJM receptors) have a spatial distribution and single data population indicative of naturally occurring lithium and are well within regional background levels. Review of the potential risk issues involved with lithium in surface soils indicates that risks to ecological receptors are highly unlikely and agrees with the other lines of evidence that it is not necessary to carry lithium forward in the ECOPC identification process. Lithium is, therefore, not considered an ECOPC in surface soil for the LWNEU and is not further evaluated quantitatively.

4.8 Molybdenum

Molybdenum had an upper-bound EPC in surface soil (for non-PMJM receptors) greater than the tESL so was carried forward to the professional judgment step. The lines of evidence used to determine whether molybdenum should be retained as an ECOPC are summarized below.

4.8.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, based on process knowledge, molybdenum is unlikely to be present in RFETS soil as a result of historical site-related activities.

4.8.2 Evaluation of Spatial Trends

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, based on spatial distribution trend analysis, molybdenum concentrations in surface soil for the LWNEU reflect variations in naturally occurring molybdenum.

4.8.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for the natural log-transformed data set for molybdenum in surface soil for non-PMJM receptors within LWNEU (Figure A3.4.8) indicates the presence of a single background population. There is a gap between 1.09 mg/kg and the cluster of three highest molybdenum concentrations with concentrations between 2.5 and 2.7 mg/kg, but

the average of the three samples coincides with the background population line projected from the lower molybdenum concentrations.

4.8.4 Comparison to RFETS Background and Other Background Data Sets

Background samples were all below detection limits. Molybdenum was detected in 15 of the 22 surface soil samples collected in the LWNEU. Molybdenum concentrations in surface soil for non-PMJM receptors within LWNEU range from 0.202 to 5.30 mg/kg, with a mean of 0.967 mg/kg and a standard deviation of 1.26 mg/kg (Table A3.2.6). The reported background concentrations for molybdenum in surface soil of Colorado and bordering states range from 3.0 to 7.0 mg/kg, with a mean of 1.59 mg/kg and a standard deviation of 0.522 mg/kg (Table A3.4.1) (Shacklette and Boerngen 1984). The maximum detection of 5.3 mg/kg was collected with three other samples that were all nondetects and had detection limits of 5.0 to 5.4 mg/kg. All other detected values ranged from 0.202 to 1.09 mg/kg, similar to the background nondetected data. Detected concentrations of molybdenum in surface soil samples at the LWNEU are well within lower range of background concentrations of molybdenum in surface soils of Colorado and bordering states.

4.8.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for molybdenum in the LWNEU (5.3 mg/kg) exceeds the NOAEL ESL for two receptor groups, terrestrial plants (2.0 mg/kg), and deer mouse insectivore (1.90 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 6.97 to 275 mg/kg. Only the ESL for terrestrial plants is within the range of background concentrations. No molybdenum Eco-SSLs are currently available.

4.8.6 Conclusion

The weight of evidence presented above shows that molybdenum concentrations in LWNEU surface soil for non-PMJM receptors are unlikely to be a result of historical site-related activities based on process knowledge, and that the spatial distribution trend and the presence of a single data population are indicative of naturally occurring molybdenum. Based on the information reviewed as part of the professional judgment process, molybdenum is not considered an ECOPC in surface soil for the LWNEU and, therefore, is not further evaluated quantitatively.

4.9 Nickel

Nickel had an upper-bound EPC in surface soil (for non-PMJM receptors) greater than the tESL so was carried forward to the professional judgment step. In addition, nickel was also determined to be an ECOI in surface soil for PMJM receptors. The lines of evidence used to determine whether nickel should be retained as an ECOPC are summarized below.

4.9.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, based on process knowledge, indicates a potential for nickel to have been released into RFETS soil because of the moderate nickel metal inventory and presence of nickel in waste generated during former operations. However, these operations took place in the former Industrial Area, which is remote from the LWNEU. Therefore, nickel is unlikely to be present in LWNEU soil as a result of historical site-related activities.

4.9.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, based on spatial distribution trend analysis, nickel concentrations in surface soil for the LWNEU reflect variations in naturally occurring nickel.

Surface Soil (PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, based on spatial distribution trend analysis, nickel concentrations in surface soil for PMJM receptors for the LWNEU reflect variations in naturally occurring nickel.

4.9.3 Pattern Recognition

Surface Soil (Non-PMJM and PMJM)

The probability plot for the natural log-transformed data set for nickel in surface soil in LWNEU (Figure A3.4.9) nickel suggests the presence of a single background population.

4.9.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Nickel was detected in each of the 22 surface soil non-PMJM samples collected in the LWNEU. Nickel concentrations in surface soil at the LWNEU range from 7.0 to 22.0 mg/kg, with a mean concentration of 14.0 mg/kg and a standard deviation of 3.02 mg/kg (Table A3.2.6). Background concentrations of nickel range from 3.8 to 14.0 mg/kg, with a mean of 9.6 mg/kg and a standard deviation of 2.59 mg/kg (Table A3.2.6).

The reported background concentrations for nickel in surface soil of Colorado and bordering states range from 5.0 to 700.0 mg/kg (Table A3.4.1), with an arithmetic mean of 18.8 mg/kg and a standard deviation of 39.8 mg/kg (Shacklette and Boerngen 1984). Nickel concentrations reported in surface soil samples at the LWNEU (7.0 to 22.0 mg/kg) are well within the regional background concentration range.

Surface Soil (PMJM)

Nickel was detected in each of the nine surface soil samples collected at the LWNEU PMJM habitats. Nickel concentrations in surface soil (PMJM) samples within LWNEU range from 11.3 to 18.2 mg/kg, with a mean concentration of 15.3 mg/kg and a standard deviation of 2.05 mg/kg (Table A3.2.8). Background concentrations of nickel range from 3.8 to 14.0 mg/kg, with a mean of 9.6 mg/kg and a standard deviation of 2.59 mg/kg (Table A3.2.8).

4.9.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for nickel in the LWNEU (19.7 mg/kg) exceeds the NOAEL ESL for six receptor groups, insectivorous mourning dove (1.24 mg/kg), American kestrel (13.0 mg/kg), herbivorous deer mouse (16.0 mg/kg), insectivorous deer mouse (0.43 mg/kg), coyote generalist (6.02 mg/kg), and insectivorous coyote (1.86 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 30 to 200 mg/kg. All of the ESLs exceeded by the UTL (except the herbivorous deer mouse) are lower than the MDC in background surface soils (14 mg/kg). No nickel Eco-SSLs are currently available for any receptor (the nickel Eco-SSL document is "pending").

Surface Soil (PMJM)

The MDC for nickel in the LWNEU (18.2 mg/kg) exceeds the NOAEL ESL for PMJM (0.51 mg/kg). However, the probability plots indicate the presence of a single background population. Therefore, although the MDC and UTL for nickel exceed the PMJM ESL, the ecological risks to this receptor group within LWNEU is expected to be similar to risks associated with naturally occurring nickel concentrations site wide.

4.9.6 Conclusion

The weight of evidence presented above shows that nickel concentrations in LWNEU surface soil for non-PMJM and PMJM receptors represent a single data population indicative of naturally occurring nickel. Based on the information reviewed as part of the professional judgment process, nickel is not considered an ECOPC in surface soil for the LWNEU and, therefore, is not further evaluated quantitatively.

4.10 Radium-228

A background comparison analysis could not be performed for radium-228 in surface soil/surface sediment in the LWNEU because there was a single sample location within the EU. However, since the single radium-228 activity (considered MDC) and its UCL exceeded the PRG, radium-228 was carried forward to the professional judgment step per the CRA methodology. The lines of evidence used to determine if radium-228 should be retained as a COC are summarized below.

4.10.1 Summary of Process Knowledge

The potential for radium-228 to be a COC in the LWNEU is very low since it was not used at RFETS. The ChemRisk Task 1 Report did not identify radium-228 as a radionuclide used at RFETS (CDH 1991) and no radium-228 waste was reported to have been generated.

4.10.2 Evaluation of Spatial Trends

Surface Soil/Surface Sediment

Figure A3.4.10 shows the single location where radium-228 was sampled within LWNEU. The single radium-228 activity of 0.930 pCi/g exceeded the PRG of 0.111 pCi/g. This radium-228 activity is similar to activities throughout the site and is less than the site background MDC of 4.10 pCi/g.

4.10.3 Pattern Recognition

Surface Soil/Surface Sediment

A probability plot for radium-228 activity could not be generated because there was a single sample result for the LWNEU data set.

4.10.4 Comparison to RFETS Background and Other Background Data Sets

There was a single sample result for radium-228 in surface soil/surface sediment at LWNEU and, therefore, a statistical background comparison could not be performed. The radium-228 surface soil/surface sediment of 0.930 pCi/g does not exceed the site background MDC of 4.10 pCi/g. The site background activities for radium-228 in surface soil/ surface sediment range from 0.200 pCi/g to 4.10 pCi/g, with a mean of 1.60 pCi/g and a standard deviation of 0.799 pCi/g (Table A3.2.2). Therefore, the activity of radium-228 in surface soil/surface sediment at LWNEU is well within site background activities.

4.10.5 Risk Potential for HHRA

Surface Soil/Surface Sediment

The radium-228 MDC for surface soil/surface sediment is 0.930 pCi/g and the PRG is 0.111 pCi/g. Site background activities range from 0.200 to 4.10 pCi/g, which indicates that all site background activities for radium-228 exceed the PRG. This suggests that the radium-228 PRG of 0.111 pCi/g is very conservative and based on an excess carcinogenic risk of 1E-06, therefore, the risk to human health is well within the NCP risk range of 10^{-6} to 10^{-4}. Furthermore, because radium-228 activities in the LWNEU appear to represent naturally occurring and because radium-228 was not used at the site, this risk is not likely associated with any releases from RFETS.

4.10.6 Conclusion

The weight of evidence presented above shows that the single radium-228 activities in surface soil/surface sediment in the LWNEU is not a result of RFETS activities, but rather representative of naturally occurring activities. There is no evidence of a release from potential sources inside or outside the LWNEU that would impact radium-228 activities in surface soil/surface sediment. However, radium-228 activities in surface soil/surface sediment across RFETS, including the sample collected in LWNEU, are above the PRG. However, the radium-228 activity in surface soil/surface sediment sample at the LWNEU is much lower than the site background MDC. Radium-228 was not used or generated at RFETS and is, therefore, not considered a COC in surface soil/ surface sediment for the LWNEU and not further evaluated quantitatively.

4.11 Selenium

Selenium had an upper-bound EPC in surface soil (for non-PMJM receptors) greater than the tESL so was carried forward to the professional judgment step. The lines of evidence used to determine whether selenium should be retained as an ECOPC are summarized below.

4.11.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, based on process knowledge, selenium is unlikely to be present in RFETS soil as a result of historical site-related activities.

4.11.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, a spatial concentration trend for selenium in surface soil at RFETS is not apparent. Therefore, based on this line of evidence, selenium concentrations in surface soil reflect variations in naturally occurring selenium.

4.11.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for the natural log-transformed data set for selenium in surface soil for non-PMJM receptors within LWNEU (Figure A3.4.11) contains too many nondetected concentrations to draw a definitive conclusion about the presence of a single background population.

4.11.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Selenium was detected in only two of the 22 surface soil samples collected in the LWNEU. Selenium concentrations in surface soil at the LWNEU range from 0.660 to 0.780 mg/kg, with a mean concentration of 0.339 mg/kg and a standard deviation of 0.181 mg/kg (Table A3.2.6). Background concentrations of selenium range from 0.680 to 1.40 mg/kg, with a mean of 0.628 mg/kg and a standard deviation of 0.305 mg/kg (Table A3.2.6). Given that selenium was detected at only two locations out of the 22 sampling locations within LWNEU, a statistical background analysis could not be performed. However, the two detected concentrations of selenium in surface soil at LWNEU are within site background concentrations and do not exceed the site background MDC.

Table A3.4.1 shows that the reported background concentrations for selenium in surface soil of Colorado and bordering states range from 0.10 to 4.32 mg/kg, with a mean of 0.349 mg/kg and a standard deviation of 0.415 mg/kg (Shacklette and Boerngen 1984). The surface soil selenium concentrations detected at two out of 22 sampling locations at the LWNEU (0.660 and 0.780 mg/kg) are well within the site background concentrations as well as within the lower range of the regional background concentrations.

4.11.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for selenium in the LWNEU (0.78 mg/kg) exceeds only one NOAEL ESL group receptor, the insectivorous deer mouse (0.75 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 0.87 to 70.0 mg/kg. The selenium MDC and UTL (0.78 mg/kg) are approximately half as much as the site background MDC (1.4 mg/kg) indicating that the selenium concentrations in the LWNEU are most likely due to local variations in natural sources. No selenium Eco-SSLs are currently available for any receptor (the selenium Eco-SSL document is “pending”).

4.11.6 Conclusion

Although the log-probability plot is inconclusive with regard to the presence of a single background population, the weight of evidence presented above shows that selenium concentrations in LWNEU surface soil for non-PMJM receptors are indicative of naturally occurring selenium. Based on the information reviewed as part of the professional judgment process, selenium is not considered an ECOPC in surface soil for the LWNEU and, therefore, is not further evaluated quantitatively.

4.12 Tin

For tin in surface soil, a statistical comparison between LWNEU and RFETS background data could not be performed because tin was not detected in RFETS background surface

soil samples. Tin had an upper-bound EPC in surface soil (for non-PMJM receptors) greater than the tESL so was carried forward to the professional judgment step. The lines of evidence used to determine whether tin should be retained as an ECOPC are summarized below.

4.12.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates the potential for tin to have released into RFETS soil because of the moderate tin metal inventory. However, tin was used in the former Industrial Area, which is remote from the LWNEU. Therefore, tin is unlikely to be present in LWNEU soil as a result of historical site-related activities.

4.12.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the results of a spatial concentration trend analysis for tin concentrations in surface soil indicates that tin concentrations in surface soil for the LWNEU reflect variations in naturally occurring tin.

4.12.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for the natural log-transformed data set for tin in surface soil for non-PMJM receptors within LWNEU (Figure A3.4.12) that includes nondetect concentrations is inconclusive. The majority of the 22 samples form an apparent background population ranging from 0.29 to 1.25 mg/kg with four anomalous samples (SS20019WC, SS20020WC, SS20025WC and SS20032WC) with significantly higher concentrations (12.6, 13.0, 13.55, and 93.3 mg/kg, respectively). Three of those samples are nondetect values. The probability plots are inconclusive with regard to determining a background population.

4.12.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Tin was below detection limits for all background data. Detection limits ranged from 2.7 to 5.8 mg/kg. Tin was detected in nine of the 22 surface soil samples collected in the LWNEU. Tin concentrations in surface soil samples at the LWNEU range from 0.289 to 93 mg/kg, with a mean concentration of 6.56 mg/kg and a standard deviation of 19.9 mg/kg (Table A3.2.6). The reported background concentrations for tin in surface soil of Colorado and bordering states range from 0.12 to 5.0 mg/kg, with a mean concentration of 1.15 mg/kg and a standard deviation of 0.772 mg/kg (Table A3.4.1) (Shacklette and Boerngen 1984). One location exists in the LWNEU that is above the

range of site background detection limits. While this observation is consistent with the hypothesis that EU levels are similar to RFETS background, because of the heavy data censoring and varying detection limits in the two data sets, it is not possible to conclude with confidence that there is no difference. Also, other than the MDC, detected concentrations of tin in surface soil samples at the LWNEU are well within the background tin concentrations in surface soils in Colorado and bordering states and within the range of nondetected values for site background.

4.12.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL of tin in the LWNEU (93.3 mg/kg) exceeds the NOAEL ESL for ten receptor groups, terrestrial plants (50 mg/kg), herbivorous mourning dove (26 mg/kg), insectivorous mourning dove (2.9 mg/kg), American kestrel (19 mg/kg), herbivorous deer mouse (45 mg/kg), insectivorous deer mouse (3.77 mg/kg), prairie dog (81 mg/kg), carnivorous coyote (70 mg/kg), insectivorous coyote (16 mg/kg) and coyote generalist (36 mg/kg). However, the next highest detected concentration of 0.638 mg/kg does not exceed any of these NOAEL ESLs. The NOAEL ESLs are modeled values based on a variety of exposure factors that are assumed to be similar to conditions at the site based on available information. In addition, the TRVs used in the derivation of the NOAEL ESLs may also have associated uncertainties, and the resulting NOAEL ESLs may be over-protective of some receptor groups. No tin Eco-SSLs are currently available. In addition, tin concentrations are most likely due to local variations in natural sources. No known sources of tin contamination have been found in the LWNEU.

4.12.6 Conclusion

The weight of evidence presented above shows that tin concentrations in LWNEU surface soil for non-PMJM receptors are not likely to be a result of historical site-related activities based on process knowledge, the spatial distribution trend and comparison of data sets. In addition, only one sample exceeded the NOAEL ESLs and, thus, tin is unlikely to cause risk to ecological populations. Tin is not considered an ECOPC in surface soil for the LWNEU and, therefore, is not further evaluated quantitatively.

4.13 Vanadium

Vanadium had an upper-bound EPC in surface soil (for non-PMJM receptors) greater than the tESL so was carried forward to the professional judgment step. The lines of evidence used to determine whether vanadium should be retained as an ECOPC are summarized below.

4.13.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, based on process knowledge, vanadium is unlikely to be present in LWNEU soil as a result of historical site-related activities.

4.13.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the results of a spatial concentration trend analysis for vanadium concentrations in surface soil at the LWNEU reflect variations in naturally occurring vanadium.

4.13.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for the natural log-transformed data set for vanadium in surface soil for non-PMJM receptors within LWNEU (Figure A3.4.13) indicates the presence of a single background population.

4.13.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Vanadium was detected in each of the 22 surface soil samples collected in the LWNEU. Vanadium concentrations in surface soil at the LWNEU range from 20.9 to 52.0 mg/kg, with a mean concentration of 34.4 mg/kg and a standard deviation of 8.11 mg/kg (Table A3.2.6). Background concentrations of vanadium range from 10.8 to 45.8 mg/kg, with a mean of 27.7 mg/kg and a standard deviation of 7.68 mg/kg (Table A3.2.6).

Vanadium concentrations at the LWNEU are well within the range of reported literature values. The reported background concentrations for vanadium in surface soil of Colorado and bordering states range from 7.0 to 300.0 mg/kg (Table A3.4.1), with a mean of 73.0 mg/kg and a standard deviation of 41.7 mg/kg (Shacklette and Boerngen 1984). Vanadium concentrations reported in surface soil samples at the LWNEU (20.9 to 52.0 mg/kg) are well within the range of regional surface soil vanadium concentrations.

4.13.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for vanadium in the LWNEU (49.7 mg/kg) exceeds the NOAEL ESL for two receptor groups, terrestrial plants (2 mg/kg), and the insectivorous deer mouse (29.9 mg/kg). The NOAEL ESLs for all other non-PMJM receptors were greater than the UTL and ranged from 64 to 1,514 mg/kg. The NOAEL ESL for the insectivorous deer mouse is less than the MDC in background soils (45.8 mg/kg) and approximately equal to the mean background concentration (27.7 mg/kg). In addition, the UTL is less than the mammalian Eco-SSL of 280 mg/kg (EPA 2005c).

The plant NOAEL ESL is lower than all background concentrations of vanadium. However, the confidence placed on the plant ESL value by the source (Efroymson et al.

1997) is low. Other studies reported in the same reference (Efroymson et al. 1997) indicate no effects at concentrations up to 40 mg/kg and low effects at concentrations up to 60 mg/kg. No vanadium Eco-SSL is currently available for plants (EPA 2005c).

4.13.6 Conclusion

The weight of evidence presented above shows that vanadium concentrations in LWNEU surface soil for non-PMJM receptors represent a single data population indicative of naturally occurring vanadium. Based on the information reviewed as part of the professional judgment process, vanadium is not considered an ECOPC in surface soil for the LWNEU and, therefore, is not further evaluated quantitatively.

4.14 Zinc

Zinc had an upper-bound EPC in surface soil (for non-PMJM receptors) greater than the tESL so was carried forward to the professional judgment step. The lines of evidence used to determine whether zinc should be retained as an ECOPC are summarized below.

4.14.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates the potential for zinc to have released into RFETS soil because of the moderate zinc metal inventory. However, zinc was used in the former Industrial Area, which is remote from the LWNEU. Therefore, zinc is unlikely to be present in LWNEU soil as a result of historical site-related activities.

4.14.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the results of a spatial concentration trend analysis for zinc concentrations in surface soil for the LWNEU reflect variations in naturally occurring zinc.

4.14.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for the natural log-transformed data set for zinc in surface soil for non-PMJM receptors within LWNEU (Figure A3.4.14) indicates the presence of a single background population.

4.14.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Zinc was detected in each of the 22 surface soil samples collected in the LWNEU. Zinc concentrations collected at the LWNEU range from 43.0 to 77.5 mg/kg, with a mean

concentration of 56.1 mg/kg and a standard deviation of 10.0 mg/kg (Table A3.2.6). Sitewide background concentrations of zinc range from 21.1 to 75.9 mg/kg, with a mean of 49.8 mg/kg and a standard deviation of 12.2 mg/kg (Table A3.2.6). The LWNEU zinc MDC for surface soil (77.5 mg/kg) was just slightly above the site background MDC of 75.9 mg/kg.

The reported range for zinc in surface soil of the of Colorado and bordering states range from 10.0 to 2,080 mg/kg, with a mean of 72.4 mg/kg and a standard deviation of 159.0 mg/kg (Table A3.4.1) (Shacklette and Boerngen 1984). Zinc concentrations reported in surface soil samples at the LWNEU (43.0 to 77.5 mg/kg) are well within this range.

4.14.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for zinc in the LWNEU (75.0 mg/kg) exceeds the NOAEL ESL for three receptor groups, terrestrial plants (50 mg/kg), insectivorous mourning dove (0.65 mg/kg), and the insectivorous deer mouse (5.29 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 109 to 16,489 mg/kg. No zinc Eco-SSLs are currently available for any receptor (the zinc Eco-SSL document is "pending").The mourning dove and deer mouse (insectivore) ESLs are both considerably lower than the range of zinc concentrations in background soils (21.1 to 75.9 mg/kg). The terrestrial plant ESL is approximately equal to the mean background concentration of 49.8 mg/kg.

4.14.6 Conclusion

The weight of evidence presented above shows that zinc concentrations in LWNEU surface soil for non-PMJM receptors are not likely to be a result of historical site-related activities based on process knowledge, the spatial distribution trend, the presence of a single background population, and comparison of data sets. In addition, while zinc concentrations exceed several highly conservative ESLs, there is no indication that potential risks to ecological receptors from zinc are elevated. Zinc is not considered an ECOPC in surface soil for the LWNEU and, therefore, is not further evaluated quantitatively.

5.0 REFERENCES

CDH, 1991. Colorado Department of Health Project Task 1 Report (Revised 1), Identification of Chemicals and Radionuclides Used at Rocky Flats. Prepared by ChemRisk. March.

DOE, 1996. Final Phase I RFI/RI Report. Woman Creek Priority Drainage-Operable Unit 5. Appendix N. Ecological Risk Assessment for Woman Creek and Walnut Creek Watersheds at the Rocky Flats Environmental Technology Site. Golden, Colorado.

DOE, 2005. Final Comprehensive Risk Assessment Work Plan and Methodology, Rocky Flats Environmental Technology Site, Golden, Colorado. Revision 1. September.

Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten, 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants. 1997 Revision, ES/ER/TM-85/R3. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

EPA, 2003. Ecological Soil Screening Level for Aluminum – Interim Final. OSWER Directive 9285.7-60. Office of Solid Waste and Emergency Response. November.

EPA, 2005a. Ecological Soil Screening Levels for Antimony – Interim Final. OSWER Directive 9285.7-61. Office of Solid Waste and Emergency Response, February.

EPA, 2005b. Ecological Soil Screening Levels for Chromium – Interim Final. OSWER Directive 9285.7-66. Office of Solid Waste and Emergency Response, March.

EPA, 2005c. Ecological Soil Screening Levels for Vanadium – Interim Final. OSWER Directive 9285.7-75. Office of Solid Waste and Emergency Response, April.

Kabata-Pendias, A., and H. Pendias, 1992. Trace Elements in Soils and Plants. Second Edition. CRC Press, Boca Raton, Florida. 365 pp

Shacklette, H.T., and J.G. Boerngen, 1984. Element Concentrations in Soils and Other Surface Materials of the Contiguous United States. Professional Paper 1270. U.S. Geological Survey, Washington, D.C.

TABLES

Table A3.2.1

Statistical Distribution and Comparison to Background for LWNEU Surface Soil and Surface Sediment[a]

Analyte	Statistical Distribution Testing Results						Background Comparison Test		
	Background			LWNEU (excluding background samples)					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statistically Greater than Background?
Arsenic	**73**	**GAMMA**	**91.8**	**25**	**NORMAL**	**100**	**WRS**	**7.89-05**	**Yes**
Cesium-134	77	NON-PARAMETRIC	N/A	5	NON-PARAMETRIC	100	N/A	0.998	No
Cesium-137	105	NON-PARAMETRIC	N/A	10	NORMAL	100	N/A	0.638	No
Radium-228	**40**	**GAMMA**	**N/A**	**1**	**N/A**	**100**	**N/A**	**N/A**	**N/A**

[a] No background samples were collected from the LWNEU.

WRS = Wilcoxon Rank Sum.

N/A = Not applicable; all radionuclide values are considered detects.

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table A3.2.2

Summary Statistics for LWNEU Surface Soil and Surface Sediment [a,b]

Analyte	Units	Background					LWNEU (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation
Arsenic	mg/kg	73	0.270	9.60	3.42	2.55	25	2.20	9.40	5.45	1.56
Cesium-134	pCi/g	77	0.001	0.300	0.141	0.0657	5	0.002	0.110	0.0244	0.0479
Cesium-137	pCi/g	105	-0.0266	1.80	0.692	0.492	10	0.004	1.25	0.597	0.497
Radium-228	pCi/g	40	0.200	4.10	1.60	0.799	1	0.930	0.930	0.930	N/A

[a] No background samples were collected from the LWNEU.

[b] Statistics are computed using one-half the reported value for nondetects.

pCi/g = picocuries per gram.

N/A = Not available or not applicable.

Table A3.2.3

Statistical Distribution and Comparison to Background for LWNEU Subsurface Soil and Subsurface Sediment[a]

Analyte	Statistical Distribution Testing Results						Background Comparison Test		
	Background			LWNEU (excluding background samples)					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statistically Greater than Background?
Radium-228	31	GAMMA	100	4	NORMAL	N/A	N/A	0.944	No

[a] No background samples were collected from the LWNEU.

WRS = Wilcoxon Rank Sum.

N/A = Not applicable; all radionuclide values are considered detects.

Table A3.2.4

Summary Statistics for LWNEU Subsurface Soil and Subsurface Sediment [a, b]

Analyte	Units	Background					LWNEU (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation
Radium-228	pCi/g	31	1	2.10	1.45	0.320	4	1.10	1.30	1	0.0856

[a] No background samples were collected from the LWNEU.

[b] Statistics are computed using one-half the reported value for nondetects.

Table A3.2.5

Statistical Distribution and Comparison to Background for LWNEU Surface Soil Non-PMJM Receptors[a]

Analyte	Units	Statistical Distribution Testing Results						Background Comparison Test		
		Background			LWNEU (excluding background samples)					
		Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statistically Greater Than Background?
Aluminum	**mg/kg**	**20**	**NORMAL**	**100**	**22**	**NORMAL**	**100**	**t-Test_N**	**0.0296**	**Yes**
Antimony	**mg/kg**	**20**	**NON-PARAMETRIC**	**0**	**14**	**NON-PARAMETRIC**	**28.6**	**N/A**	**N/A**	**N/A**
Arsenic	mg/kg	20	NORMAL	100	22	NORMAL	100	t-Test_N	0.770	No
Barium	**mg/kg**	**20**	**NORMAL**	**100**	**22**	**NORMAL**	**100**	**t-Test_N**	**5.06E-04**	**Yes**
Boron	mg/kg	N/A	N/A	N/A	18	GAMMA	100	N/A	N/A	N/A
Cadmium	mg/kg	20	NON-PARAMETRIC	65	22	NON-PARAMETRIC	90.9	WRS	0.430	No
Chromium	**mg/kg**	**20**	**NORMAL**	**100**	**22**	**NORMAL**	**100**	**t-Test_N**	**0.00960**	**Yes**
Copper	mg/kg	20	NON-PARAMETRIC	100	22	NON-PARAMETRIC	100	WRS	0.303	No
Lead	mg/kg	20	NORMAL	100	22	GAMMA	100	WRS	0.995	No
Lithium	**mg/kg**	**20**	**NORMAL**	**100**	**22**	**NORMAL**	**100**	**t-Test_N**	**0.00152**	**Yes**
Manganese	mg/kg	20	NORMAL	100	22	NON-PARAMETRIC	100	WRS	0.134	No
Mercury	mg/kg	20	NON-PARAMETRIC	40	22	GAMMA	68.2	WRS	1.000	No
Molybdenum	**mg/kg**	**20**	**NORMAL**	**0**	**22**	**GAMMA**	**68.2**	**N/A**	**N/A**	**N/A**
Nickel	**mg/kg**	**20**	**NORMAL**	**100**	**22**	**NORMAL**	**100**	**t-Test_N**	**4.59E-06**	**Yes**
Selenium	**mg/kg**	**20**	**NON-PARAMETRIC**	**60**	**22**	**NON-PARAMETRIC**	**9.09**	**N/A**	**N/A**	**N/A**
Tin	**mg/kg**	**20**	**NORMAL**	**0**	**22**	**NON-PARAMETRIC**	**40.9**	**N/A**	**N/A**	**N/A**
Vanadium	**mg/kg**	**20**	**NORMAL**	**100**	**22**	**NORMAL**	**100**	**t-Test_N**	**0.00451**	**Yes**
Zinc	**mg/kg**	**20**	**NORMAL**	**100**	**22**	**NORMAL**	**100**	**t-Test_N**	**0.0371**	**Yes**

[a] No background samples were collected from the LWNEU.

WRS = Wilcoxon Rank Sum.

t-Test_N = Student's t-test using normal data.

N/A = Not applicable; site and/or background detection frequency less than 20%.

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table A3.2.6

Summary Statistics for LWNEU Surface Soil Non-PMJM Receptors[a,b]

Analyte	Units	Background					LWNEU (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation
Aluminum	mg/kg	20	4,050	17,100	10,203	3,256	22	7,460	17,000	11,912	2,424
Antimony	mg/kg	20	N/A	N/A	0.279	0.0784	14	0.490	1.00	2.10	2.87
Arsenic	mg/kg	20	2.30	9.60	6.09	2.00	22	2.20	9.40	5.68	1.52
Barium	mg/kg	20	45.7	134	102	19.4	22	86.4	180	126	23.0
Boron	mg/kg	N/A	N/A	N/A	N/A	N/A	18	2.75	8.40	4.89	1.43
Cadmium	mg/kg	20	0.670	2.30	0.708	0.455	22	0.220	2.20	0.933	0.666
Chromium	mg/kg	20	5.50	16.9	11.2	2.78	22	7.92	21.0	13.4	2.97
Copper	mg/kg	20	5.20	16.0	13.0	2.58	22	5.00	17.5	13.4	2.68
Lead	mg/kg	20	8.60	53.3	33.5	10.5	22	13.3	50.9	25.8	10.1
Lithium	mg/kg	20	4.80	11.6	7.66	1.89	22	4.80	16.0	9.86	2.54
Manganese	mg/kg	20	129	357	237	63.9	22	170	1,110	301	193
Mercury	mg/kg	20	0.090	0.120	0.0715	0.0310	22	0.013	0.036	0.0312	0.0185
Molybdenum	mg/kg	20	N/A	N/A	0.573	0.184	22	0.202	5.30	0.967	1.26
Nickel	mg/kg	20	3.80	14.0	9.60	2.59	22	7.00	22.0	14.0	3.02
Selenium	mg/kg	20	0.680	1.40	0.628	0.305	22	0.660	0.780	0.339	0.181
Tin	mg/kg	20	N/A	N/A	2.06	0.410	22	0.289	93.3	6.56	19.9
Vanadium	mg/kg	20	10.8	45.8	27.7	7.68	22	20.9	52.0	34.4	8.11
Zinc	mg/kg	20	21.1	75.9	49.8	12.2	22	43.0	77.5	56.1	10.0
4,4'-DDT	ug/kg	N/A	N/A	N/A	17.0	0.583	4	26.0	26.0	14.4	7.76

[a] No background samples were collected from the LWNEU.

[b] Statistics are computed using one-half the reported value for nondetects.

N/A = Not applicable.

Table A3.2.7
Statistical Distribution and Comparison to Background for Surface Soil in PMJM Habitat

Analyte	Units	Statistical Distribution Testing Results						Background Comparison Test		
		Background			LWNEU (excluding background samples)					
		Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statistically Greater Than Background?
Arsenic	mg/kg	20	NORMAL	100	9	NON-PARAMETRIC	100	WRS	0.738	No
Chromium	**mg/kg**	**20**	**NORMAL**	**100**	**9**	**NORMAL**	**100**	**t-Test_N**	**0.067**	**Yes**
Manganese	mg/kg	20	NORMAL	100	9	NORMAL	100	t-Test_N	0.118	No
Nickel	**mg/kg**	**20**	**NORMAL**	**100**	**9**	**NORMAL**	**100**	**t-Test_N**	**1.88E-06**	**Yes**
Vanadium	mg/kg	20	NORMAL	100	9	LOGNORMAL	100	WRS	0.144	No
Zinc	mg/kg	20	NORMAL	100	9	NORMAL	100	t-Test_N	0.156	No

WRS = Wilcoxon Rank Sum.

t-Test_N = Student's t-test using normal data.

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table A3.2.8
Summary Statistics For LWNEU Surface Soil in PMJM Habitat [a,b]

Analyte	Units	Background					LWNEU (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation
Arsenic	mg/kg	20	2.30	9.60	6.09	2.00	9	4.80	8.10	5.74	1.11
Chromium	mg/kg	20	5.50	16.9	11.2	2.78	9	7.92	21.0	13.1	3.68
Manganese	mg/kg	20	129	357	237	63.9	9	175	400	268	65.1
Nickel	mg/kg	20	3.80	14.0	9.60	2.59	9	11.3	18.2	15.3	2.05
Vanadium	mg/kg	20	10.8	45.8	27.7	7.68	9	21.5	52.0	31.6	8.72
Zinc	mg/kg	20	21.1	75.9	49.8	12.2	9	44.3	64.7	54.3	7.04

[a] No background samples were collected from the LWNEU.

[b] Statistics are computed using one-half the reported value for nondetects.

Table A3.2.9

Statistical Distribution and Comparison to Background for Subsurface Soil [a]

Analyte	Units	Summary Statistical for LWNEU Subsurface Soil [a]						Background Comparison Test		
		Background			LWNEU (excluding background samples)					
		Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statistically Greater than Background?
Arsenic	**mg/kg**	**45**	**NON-PARAMETRIC**	**93.3**	**14**	**NON-PARAMETRIC**	**100**	**WRS**	**0.0936**	**Yes**

[a]No background samples were collected from the LWNEU.

WRS = Wilcoxon Rank Sum.

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table A3.2.10

Summary Statistics For Subsurface Soil [a,b]

Analyte	Units	Background					LWNEU (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation
Arsenic	mg/kg	45	1.70	41.8	5.48	6.02	14	3.10	12.8	5.89	2.59

[a] No background samples were collected from the LWNEU.

[b] Statistics are computed using one-half the reported value for nondetects.

Table A3.4.1

Summary of Element Concentrations in Colorado and Bordering States Surface Soil[a]

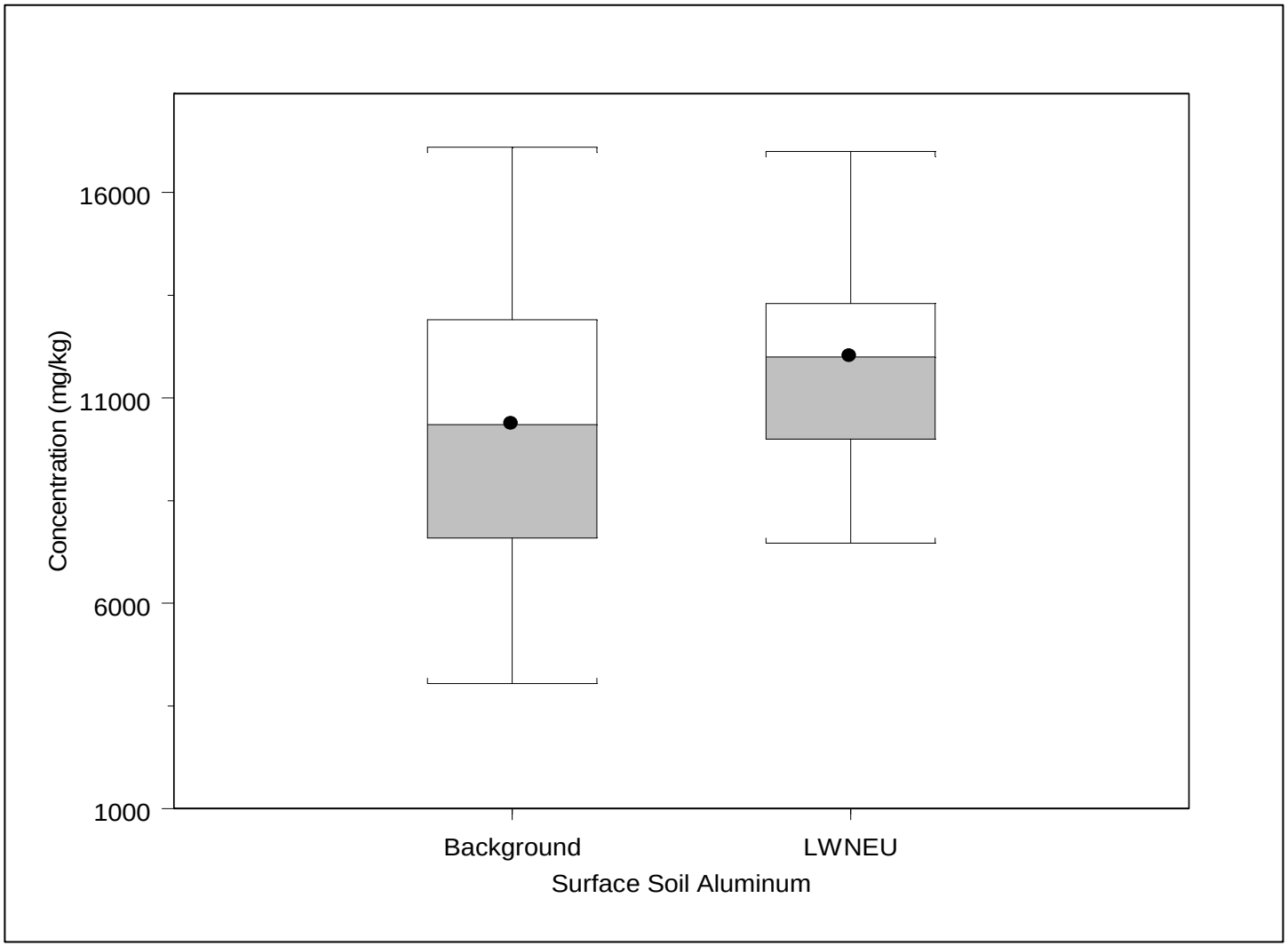
Analyte	Total Number of Results	Detection Frequency (%)	Range of Detected Values (mg/kg)	Average (mg/kg)[b]	Standard Deviation (mg/kg)[b]
Aluminum	303	100	5,000 - 100,000	50,800	23,500
Antimony	84	15.5	1.038 - 2.531	0.647	0.378
Arsenic	307	99.3	1.224 - 97	6.9	7.64
Barium	342	100	100 - 3,000	642	330
Beryllium	342	36	1 - 7	0.991	0.876
Boron	342	66.7	20 - 150	27.9	19.7
Bromine	85	50.6	0.5038 - 3.522	0.681	0.599
Calcium	342	100	0.055 - 32	3.09	4.13
Carbon	85	100	0.3 - 10	2.18	1.92
Cerium	291	16.2	150 - 300	90	38.4
Chromium	342	100	3 - 500	48.2	41
Cobalt	342	88.6	3 - 30	8.09	5.03
Copper	342	100	2 - 200	23.1	17.7
Fluorine	264	97.3	10 - 1,900	394	261
Gallium	340	99.1	5 - 50	18.3	8.9
Germanium	85	100	0.5777 - 2.146	1.18	0.316
Iodine	85	78.8	0.516 - 3.487	1.07	0.708
Iron	342	100	3,000 - 100,000	21,100	13,500
Lanthanum	341	66.3	30 - 200	39.8	28.8
Lead	342	92.7	10 - 700	24.8	41.5
Lithium	307	100	5 - 130	25.3	14.4
Magnesium	341	100	300 - 50,000	8,630	6,400
Manganese	342	100	70 - 2,000	414	272
Mercury	309	99	0.01 - 4.6	0.0768	0.276
Molybdenum	340	3.53	3 - 7	1.59	0.522
Neodymium	256	22.7	70 - 300	47.1	31.7
Nickel	342	96.5	5 - 700	18.8	39.8
Niobium	335	63.3	10 - 100	11.4	8.68
Phosphorus	249	100	40 - 4,497	399	397
Potassium	341	100	1,900 - 63,000	18,900	6,980
Rubidium	85	100	35 - 140	75.8	25
Scandium	342	85.1	5 - 30	8.64	4.69
Selenium	309	80.6	0.1023 - 4.3183	0.349	0.415
Silicon	85	100	149,340 - 413,260	302,000	61,500
Sodium	335	100	500 - 70,000	10,400	6,260
Strontium	342	100	10 - 2,000	243	212
Sulfur	85	16.5	816 - 47,760	1,250	5,300
Thallium	76	100	2.45 - 20.79	9.71	3.54
Tin	85	96.5	0.117 - 5.001	1.15	0.772
Titanium	342	100	500 - 7,000	2,290	1,350
Uranium	85	100	1.11 - 5.98	2.87	0.883
Vanadium	342	100	7 - 300	73	41.7
Ytterbium	330	99.1	1 - 20	3.33	2.06
Yttrium	342	98	10 - 150	26.9	18.1
Zinc	330	100	10 - 2,080	72.4	159
Zirconium	342	100	30 - 1,500	220	157

[a] Based on data from Shacklette and Boerngen 1984 for the states of Colorado, Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Utah, and Wyoming.

[b] One-half the detection limit used as proxy value for nondetects in computation of the mean and standard deviation.

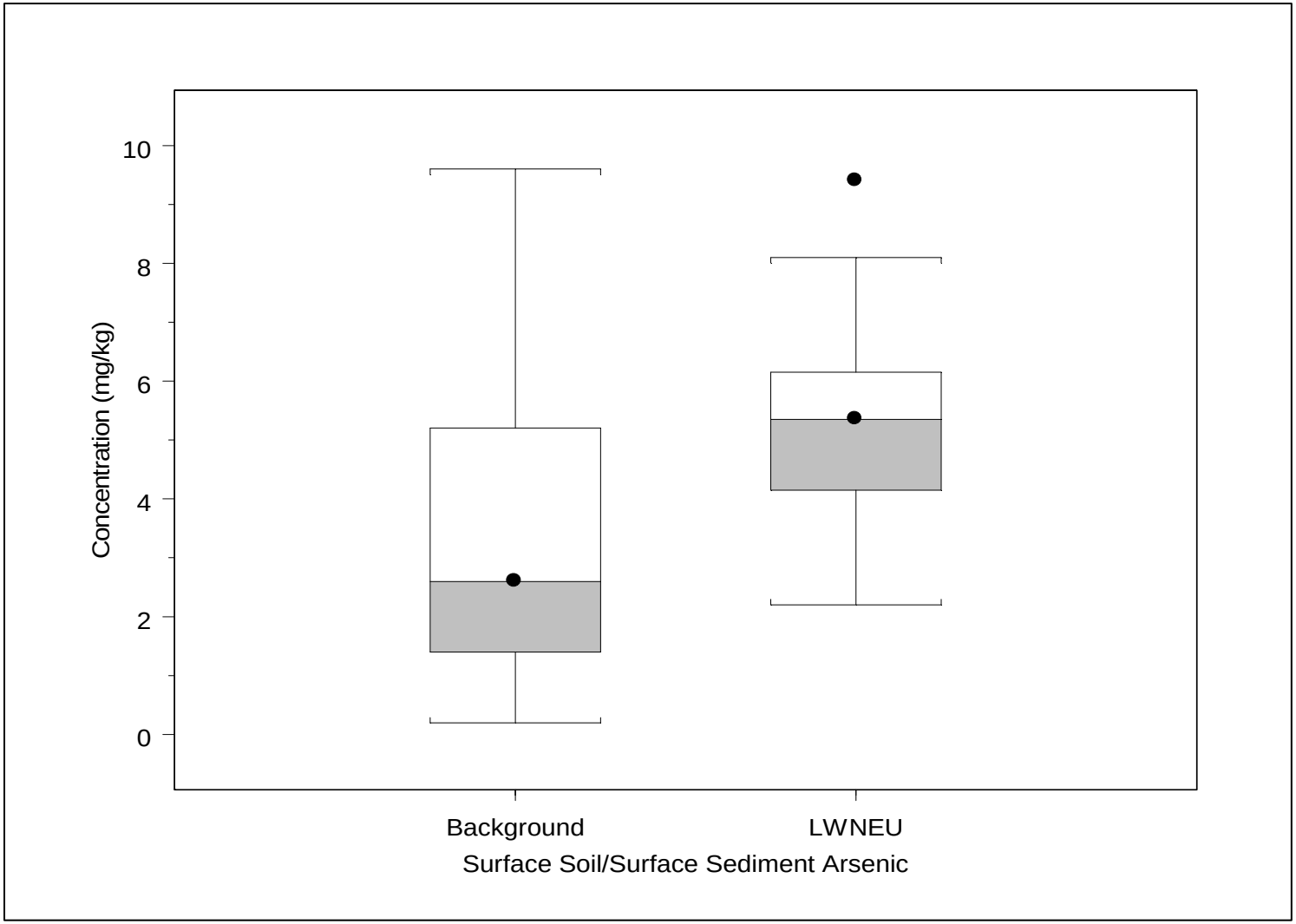
FIGURES

Figure A3.2.1
LWNEU Surface Soil Box Plots for Aluminum



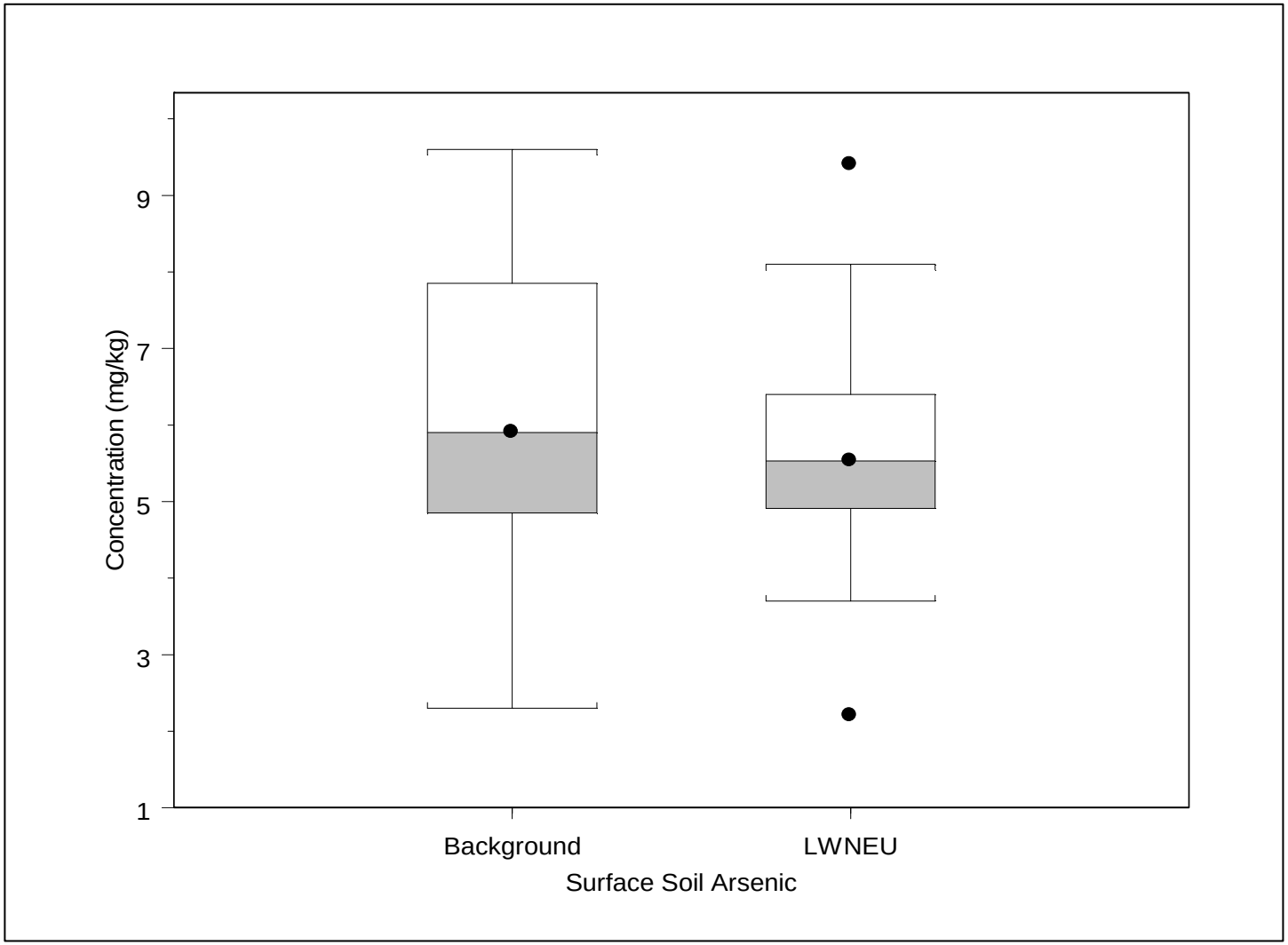
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.2
LWNEU Surface Soil/Surface Sediment Box Plots for Arsenic



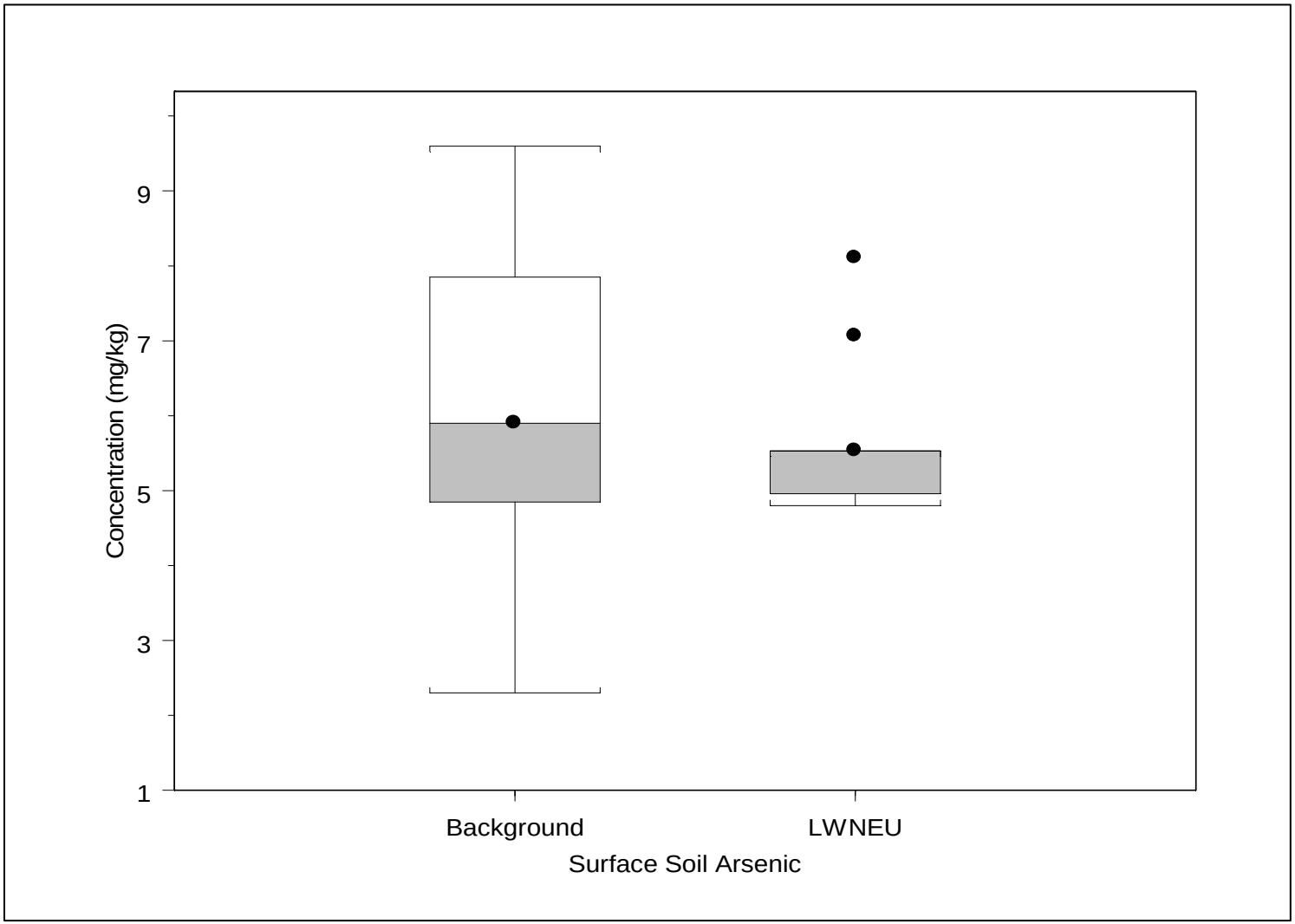
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.3
LWNEU Surface Soil Box Plots for Arsenic



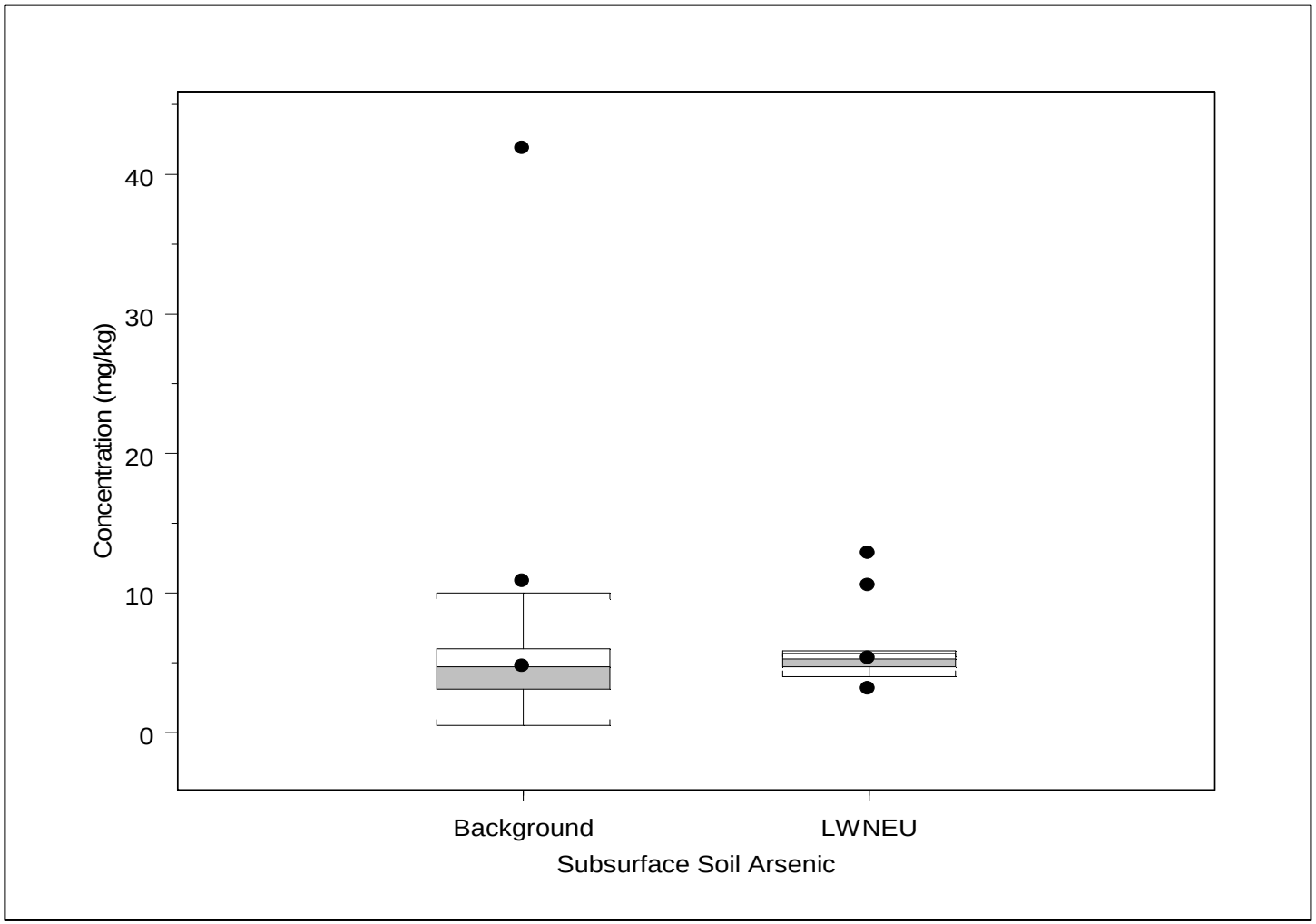
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.4
LWNEU Surface Soil Box Plots for Arsenic (PMJM)



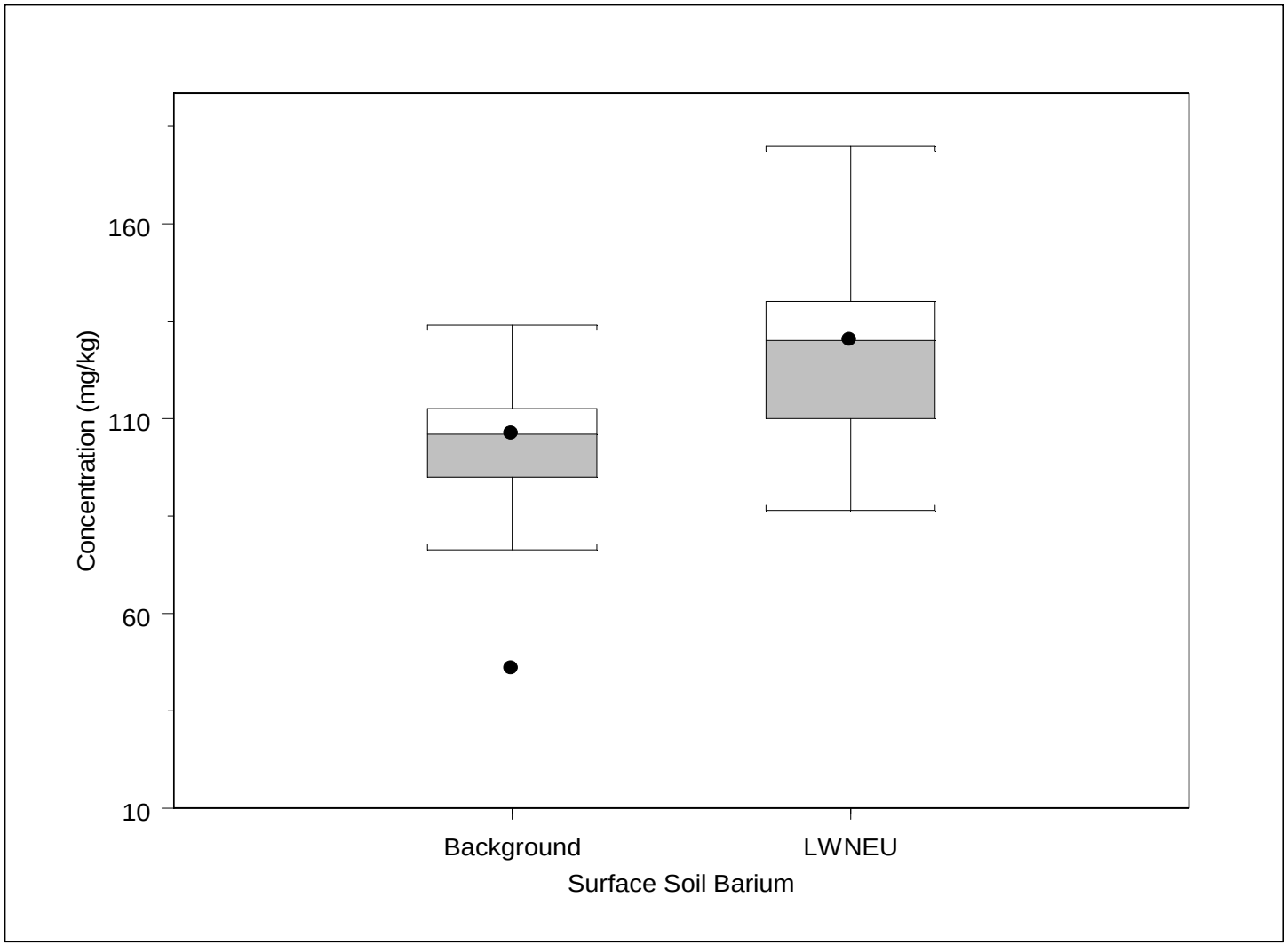
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.5
LWNEU Subsurface Soil Box Plots for Arsenic



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

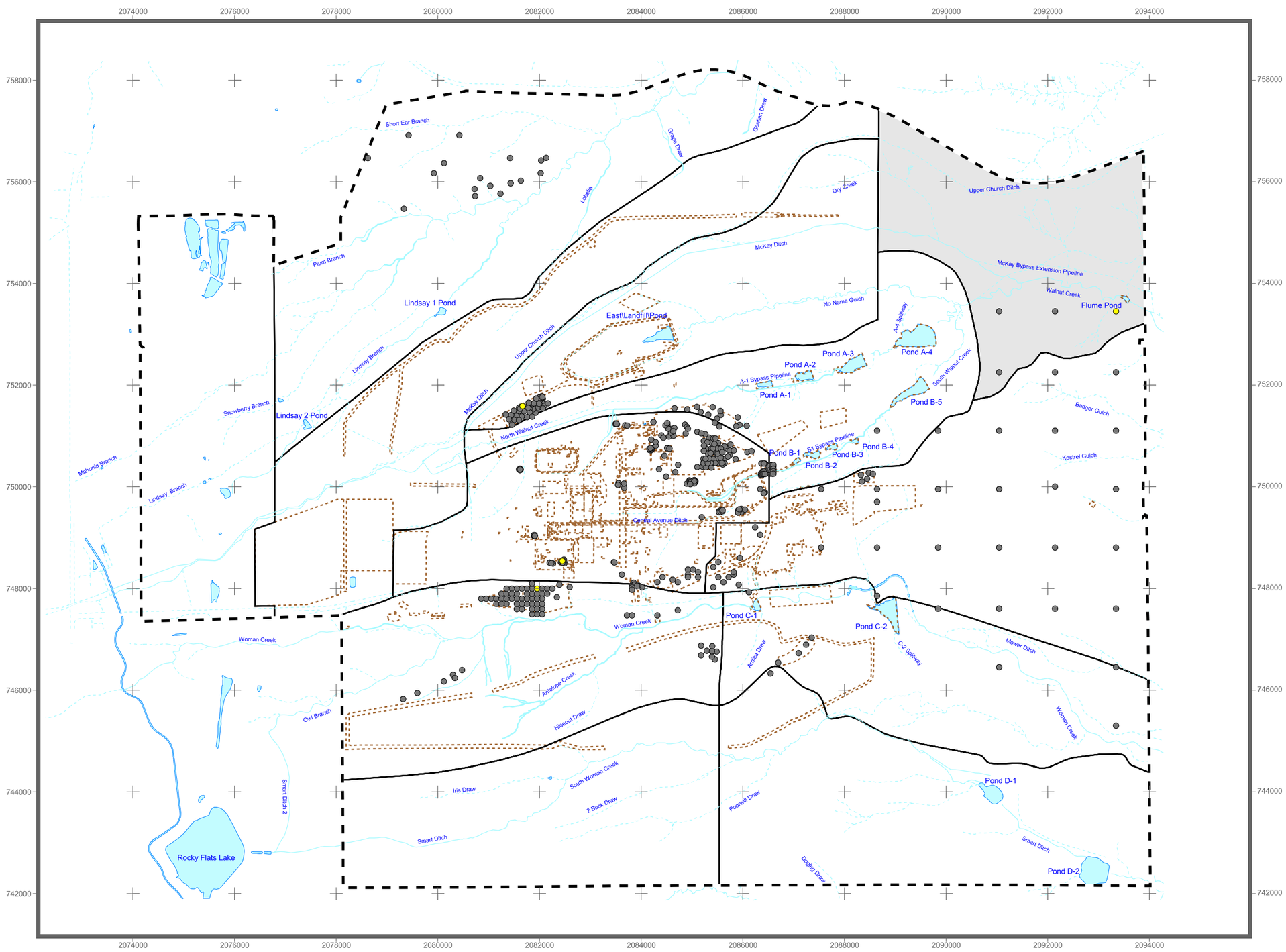
Figure A3.2.6
LWNEU Surface Soil Box Plots for Barium



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.4.6

4,4'-DDT Concentrations in Sitewide Surface Soil (Non-PMJM)



KEY

- Concentration > 3x ESL
- Concentration > ESL and <= 3x ESL
- Concentration <= ESL
- Nondetect (ND)

Min. Non-PMJM ESL = 1.20 ug/kg
3 x Min. Non-PMJM ESL = 3.61 ug/kg

Standard Map Features

- Lower Walnut Drainage EU
- Exposure Unit boundaries
- Former building where analyte was used or generated as waste
- Historical IHSS/PAC
- Pond
- Ephemeral stream
- Intermittent stream
- Perennial stream
- Site boundary

N
W E
S

0 1000 2000 Feet

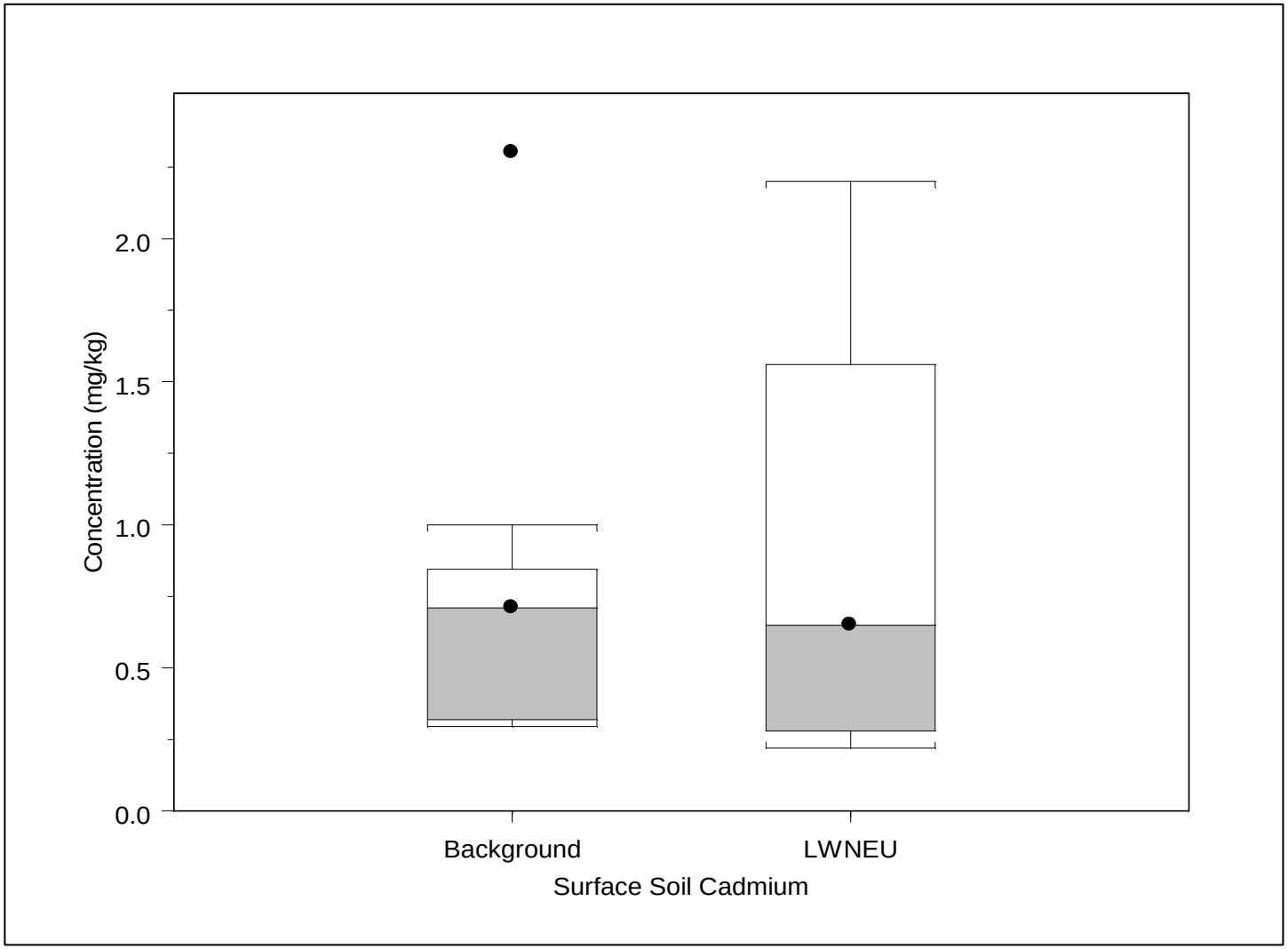
Scale 1:24,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

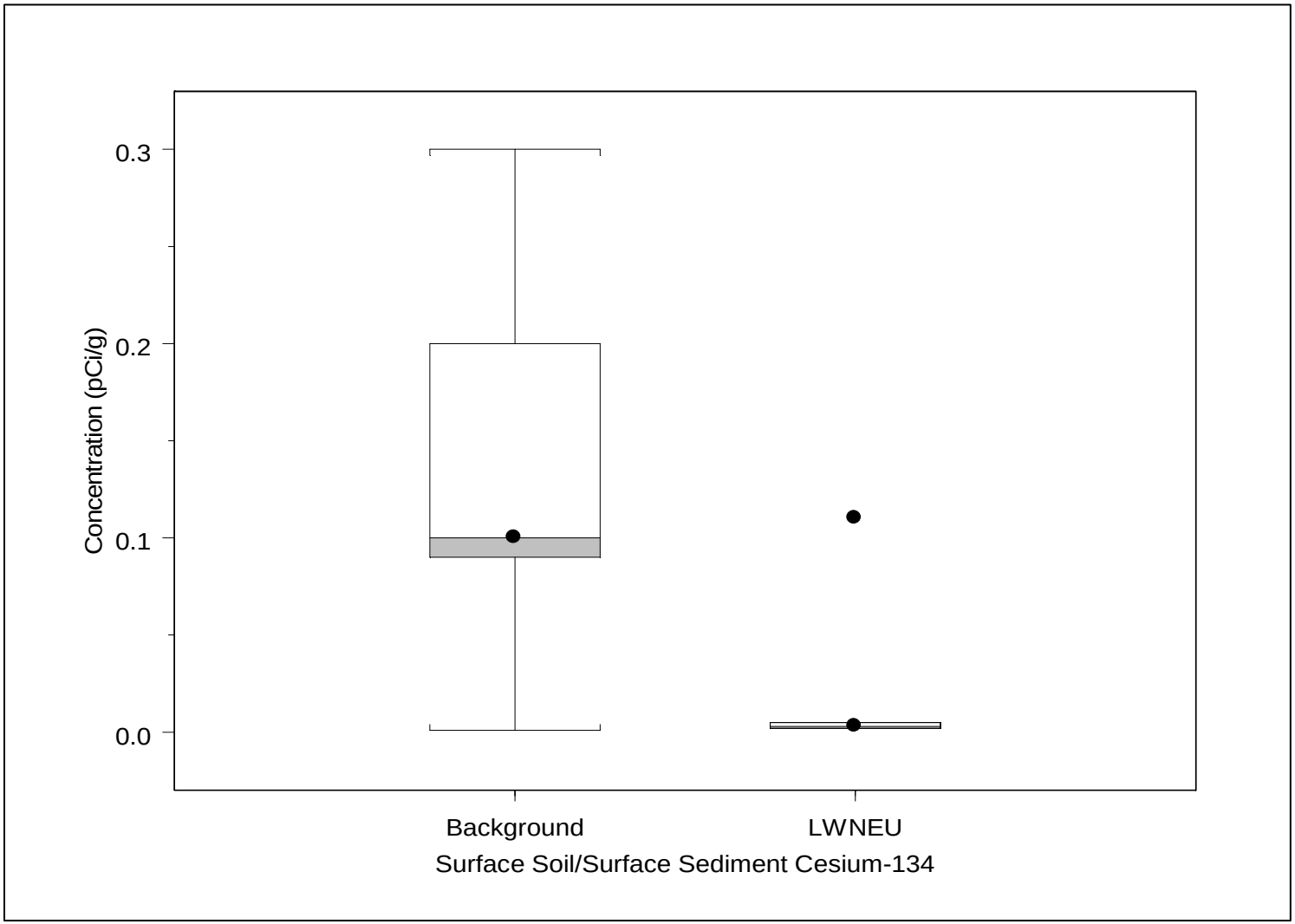
File: W:\Projects\FY2005\CRA\ProfessionalJudgement\FINAL-profjudgment.apr

Figure A3.2.7
LWNEU Surface Soil Box Plots for Cadmium



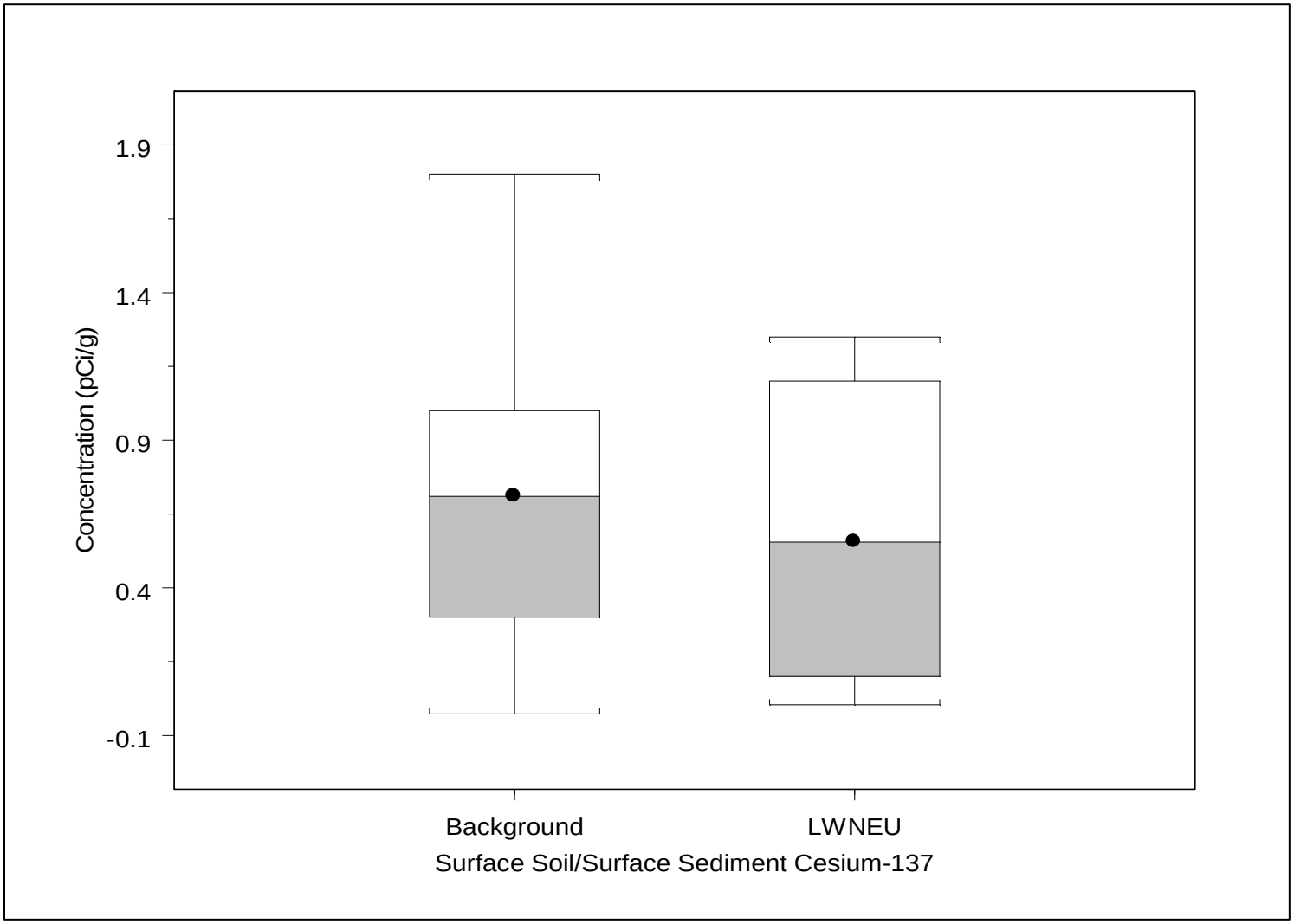
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.8
LWNEU Surface Soil/Surface Sediment Box Plots for Cesium-134



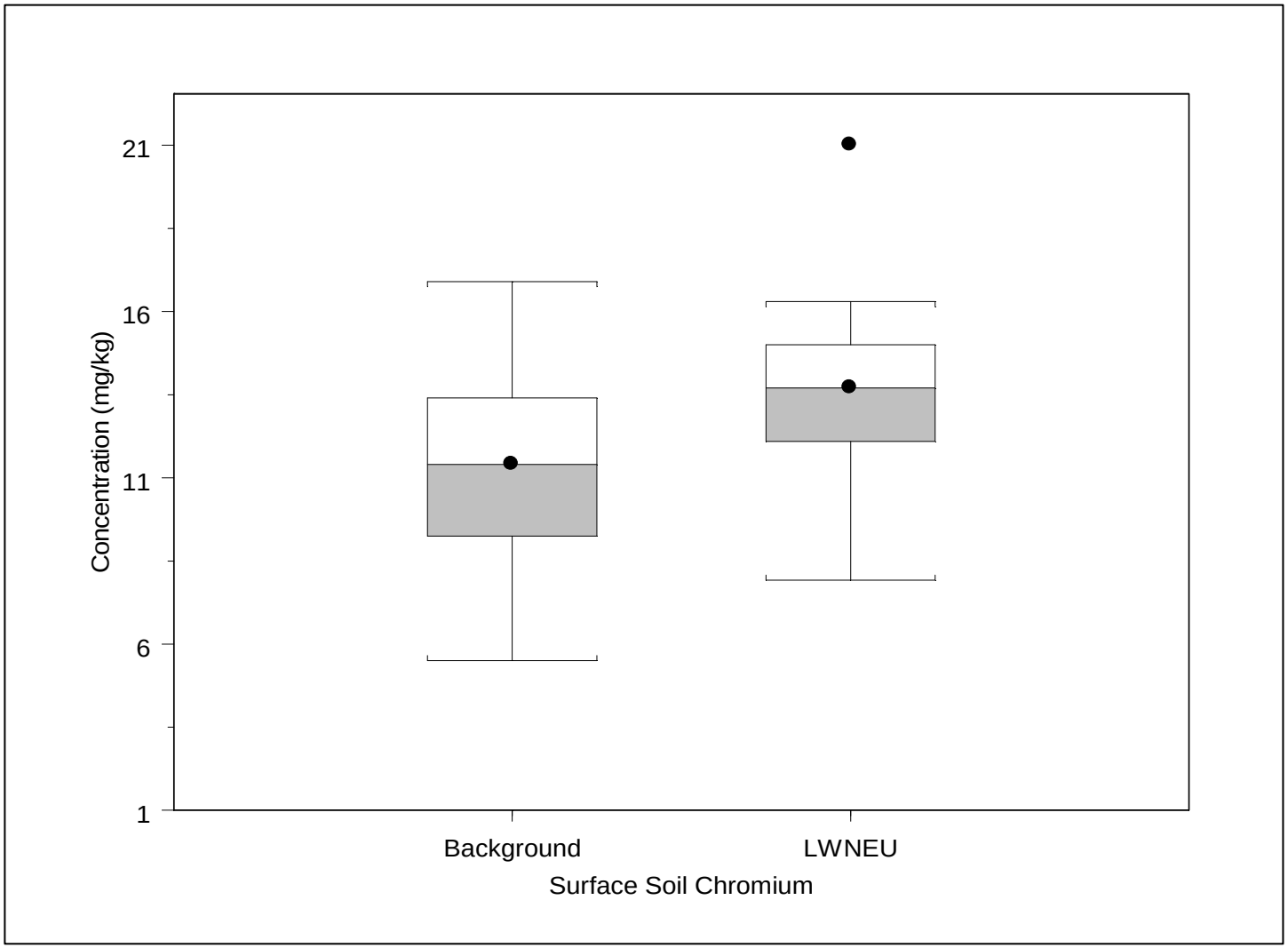
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.9
LWNEU Surface Soil/Surface Sediment Box Plots for Cesium-137



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

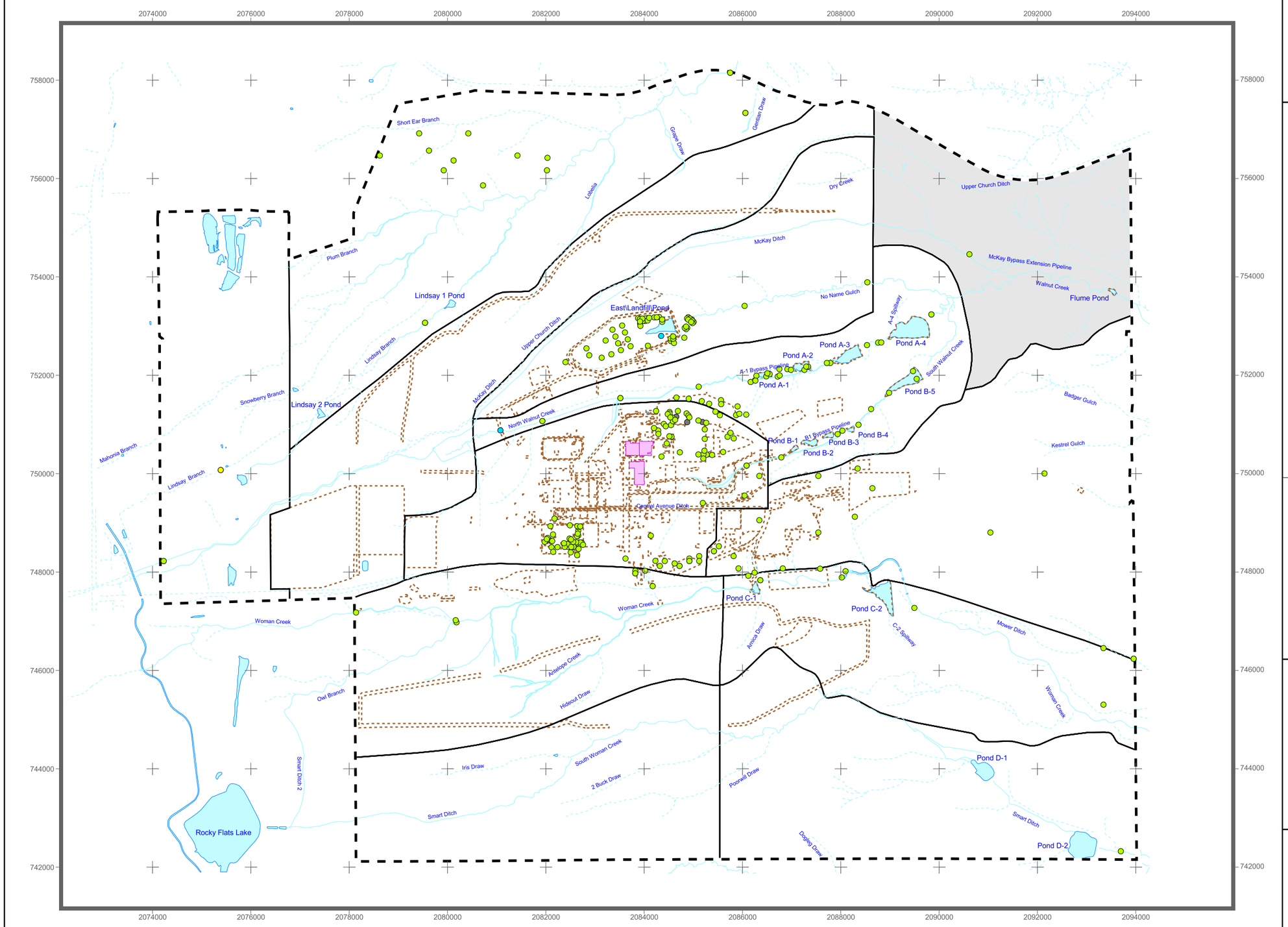
Figure A3.2.10
LWNEU Surface Soil Box Plots for Chromium



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.4.10

Radium-228 Activity in Sitewide Surface Soil/Surface Sediment



KEY

- Concentration > 3x Background MDC
- Concentration > Background MDC and <= 3x Background MDC
- Concentration > WRW PRG and <= Background MDC
- Concentration <= WRW PRG
- Nondetect (ND)

WRW PRG = 0.111 pCi/g
Background MDC = 4.10 pCi/g
3 x Background MDC = 12.3 pCi/g

Standard Map Features

- Lower Walnut Drainage EU
- Exposure Unit boundaries
- Former building where analyte was used or generated as waste
- Historical IHSS/PAC
- Pond
- Ephemeral stream
- Intermittent stream
- Perennial stream
- Site boundary

N
W E
S

0 1000 2000 Feet

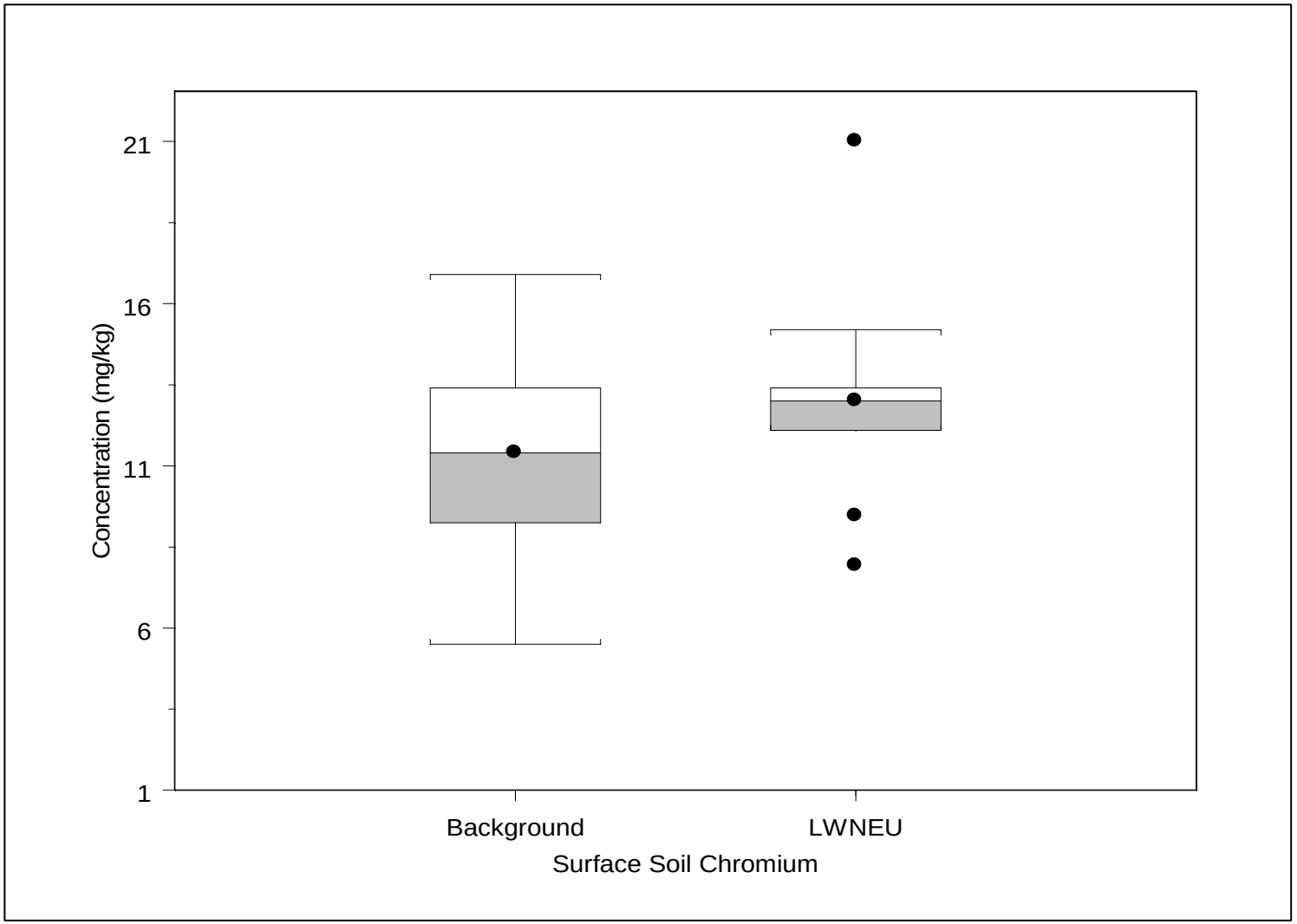
Scale 1:24,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

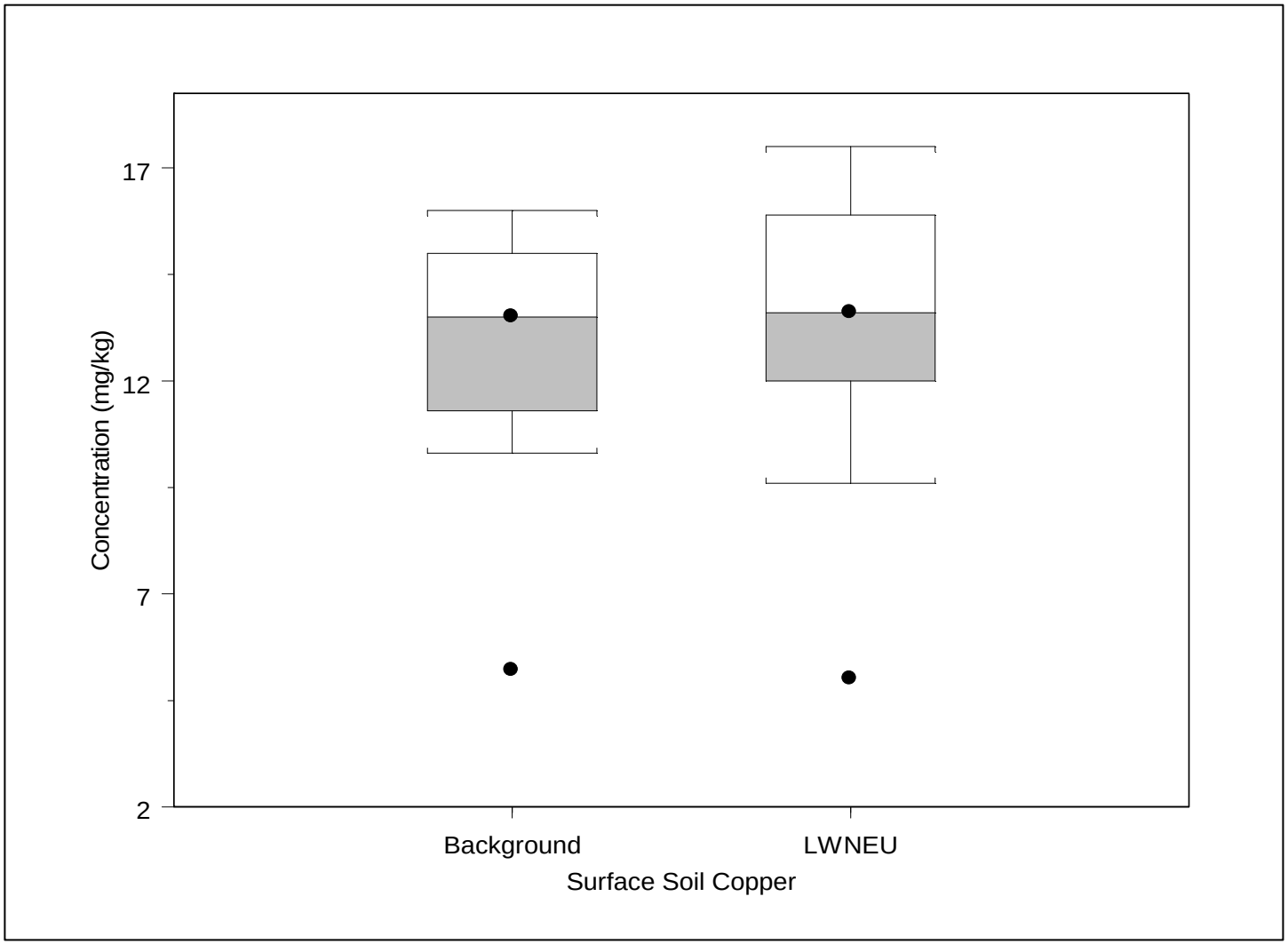
File: W:\Projects\FY2005\CRA\ProfessionalJudgement\FINAL-profjudgment.apr

Figure A3.2.11
LWNEU Surface Soil Box Plots for Chromium (PMJM)



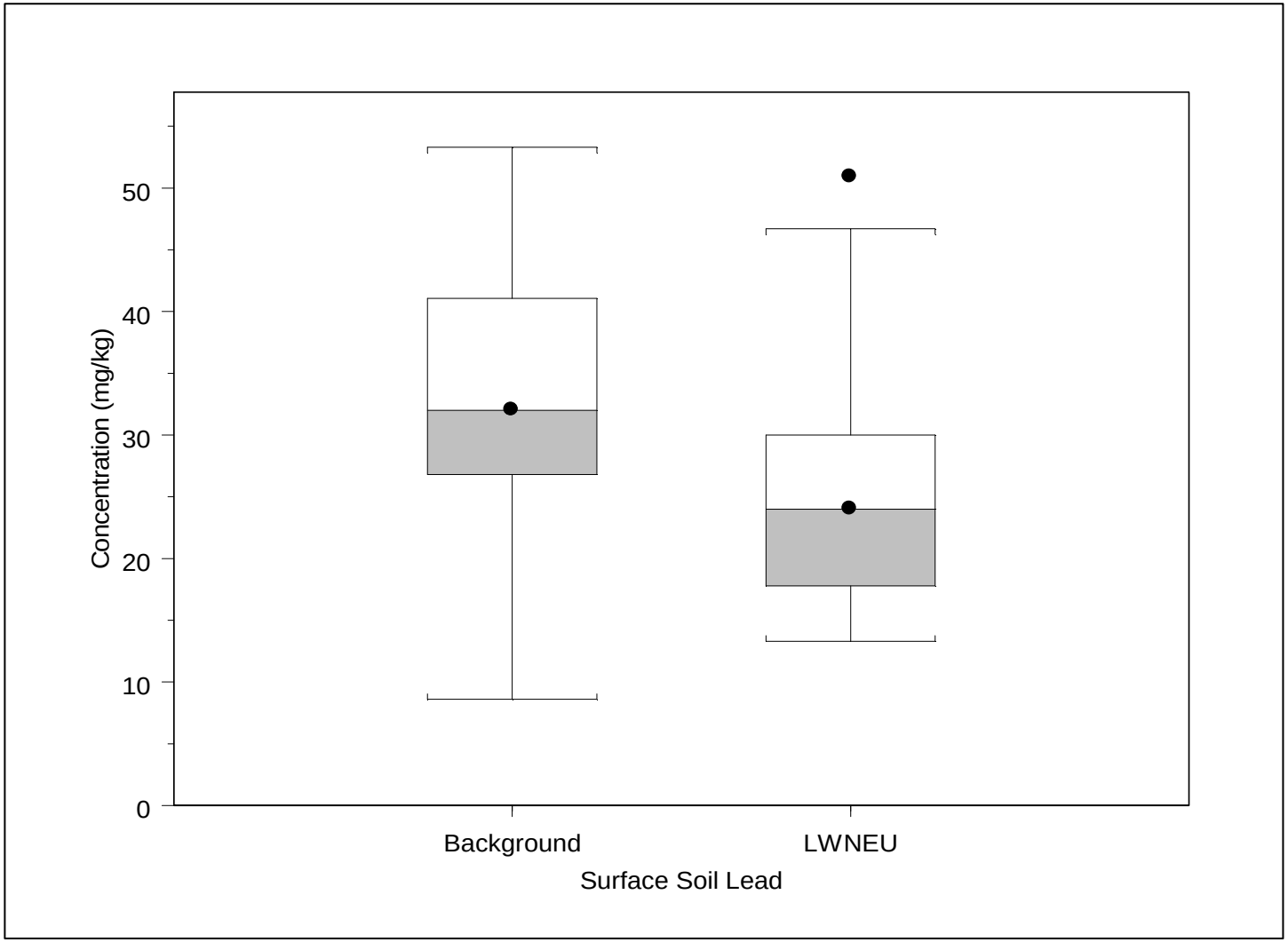
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.12
LWNEU Surface Soil Box Plots for Copper



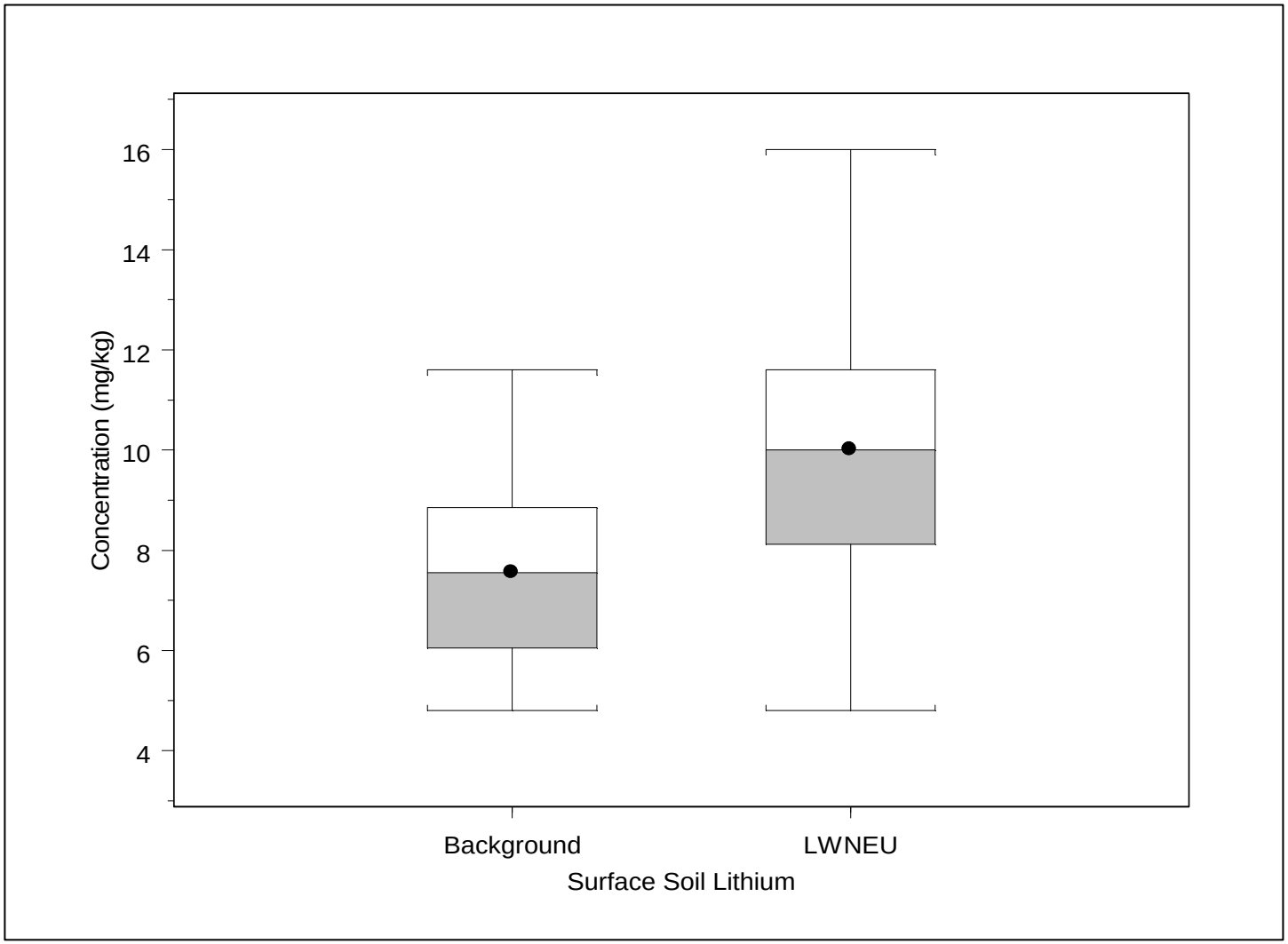
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.13
LWNEU Surface Soil Box Plots for Lead



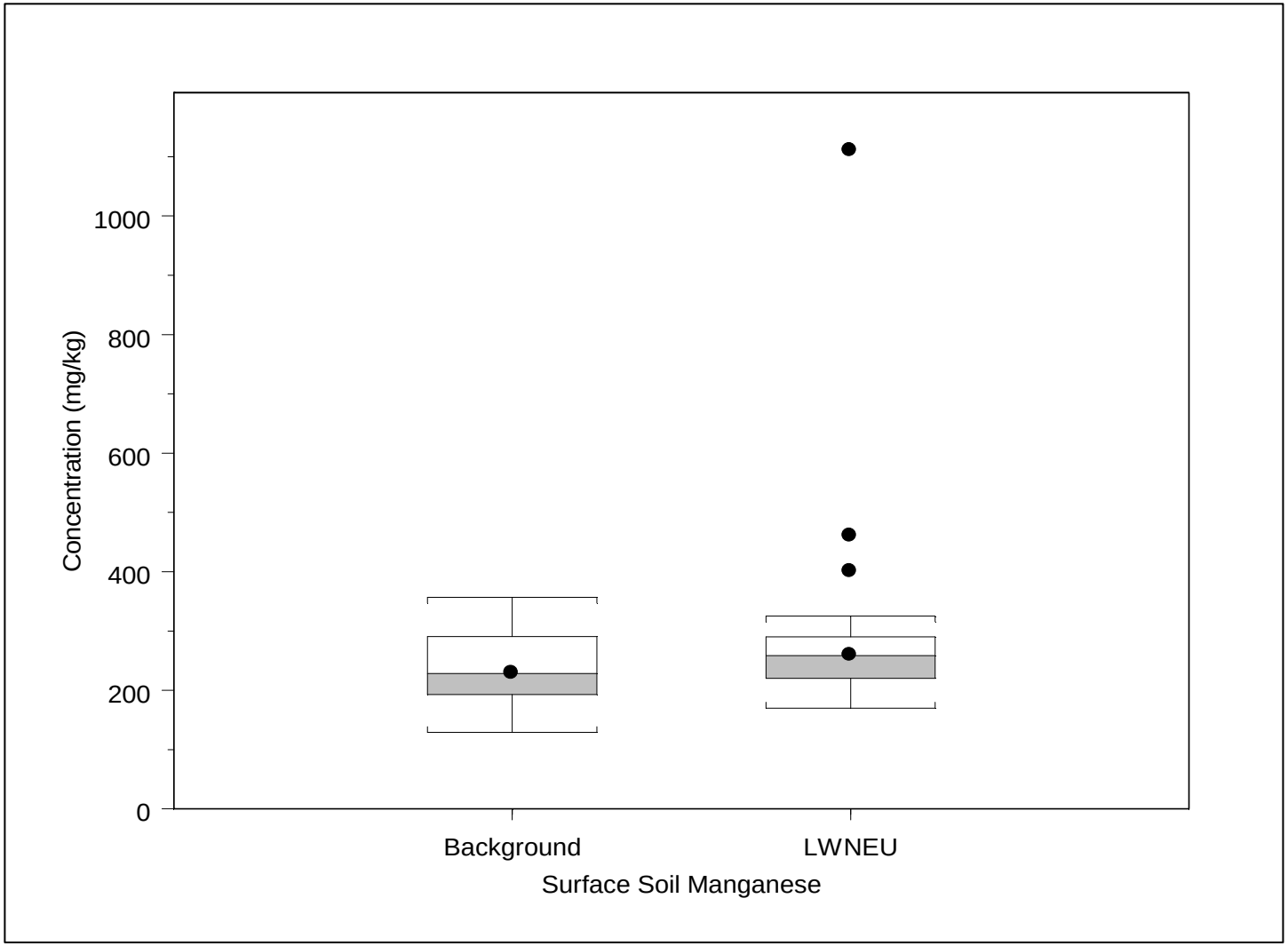
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.14
LWNEU Surface Soil Box Plots for Lithium



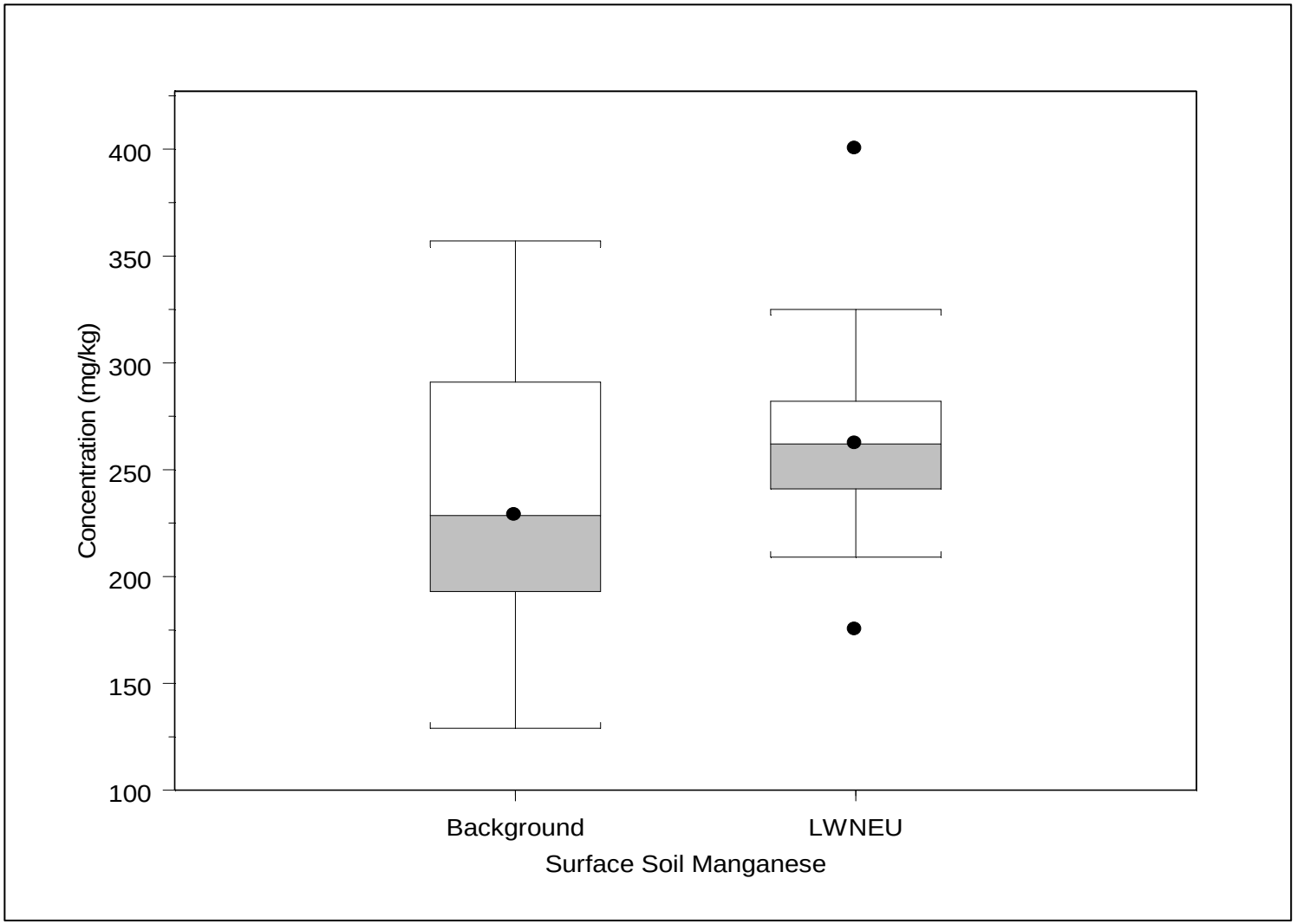
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.15
LWNEU Surface Soil Box Plots for Manganese



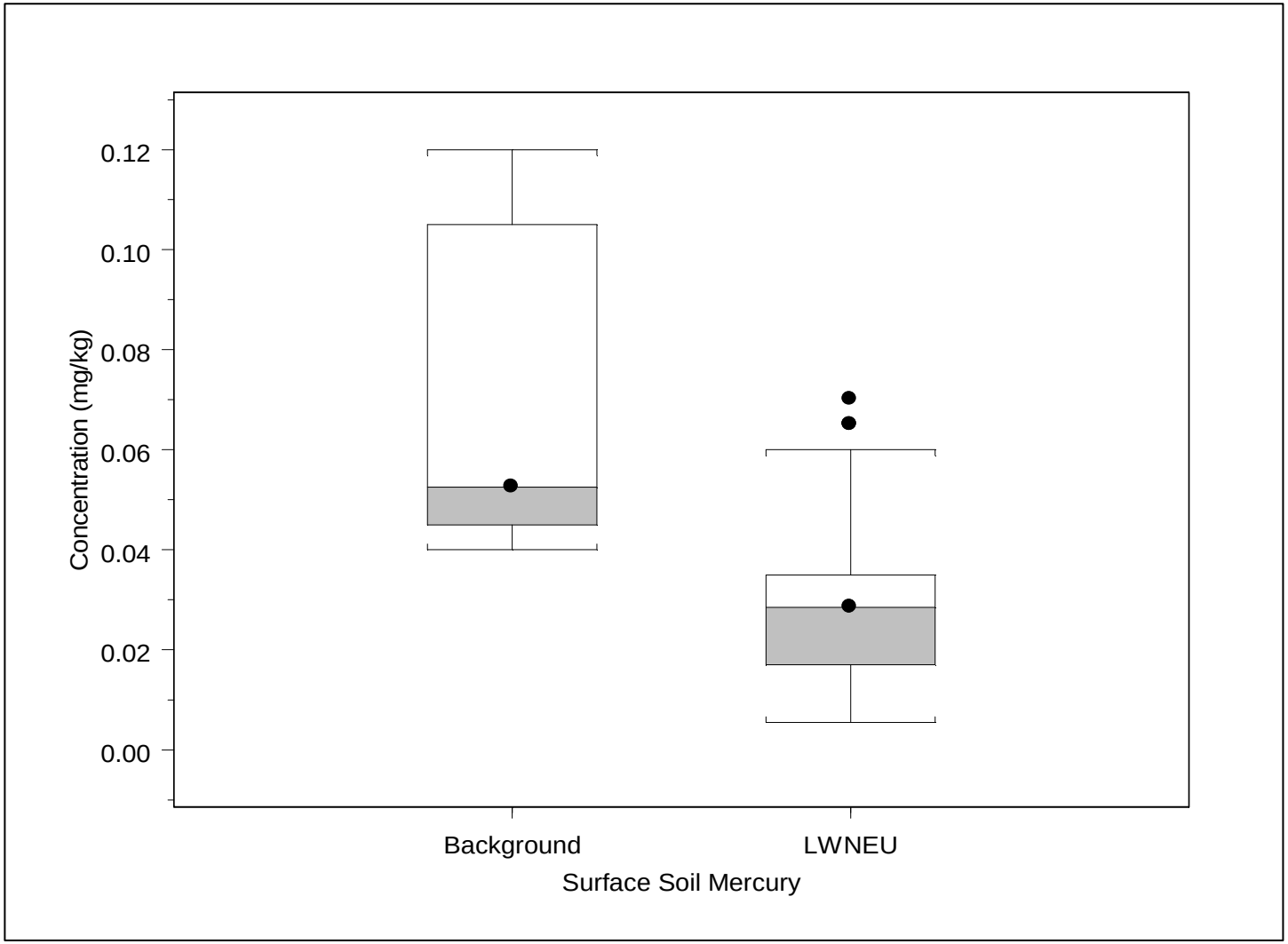
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.16
LWNEU Surface Soil Box Plots for Manganese (PMJM)



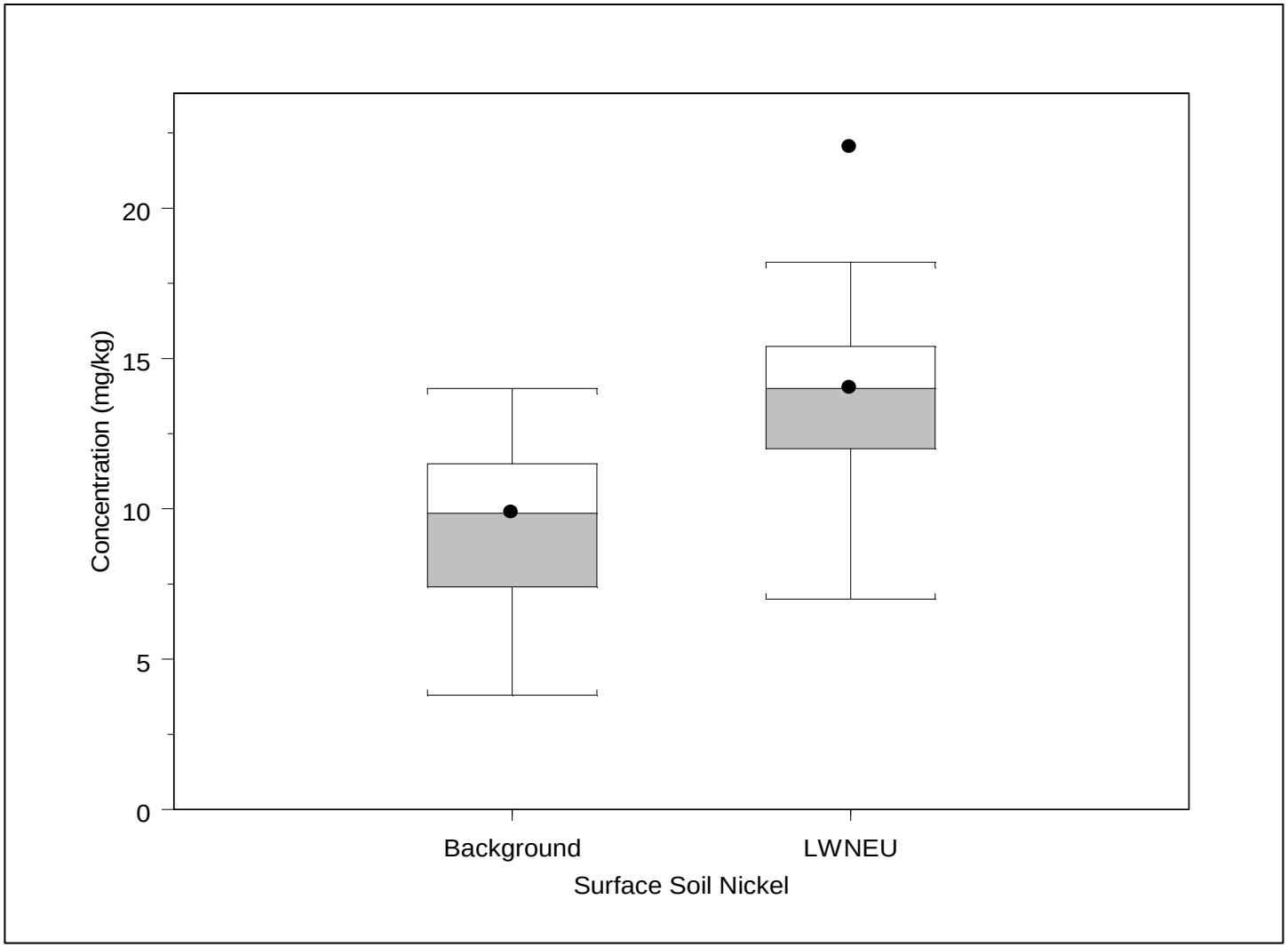
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.17
LWNEU Surface Soil Box Plots for Mercury



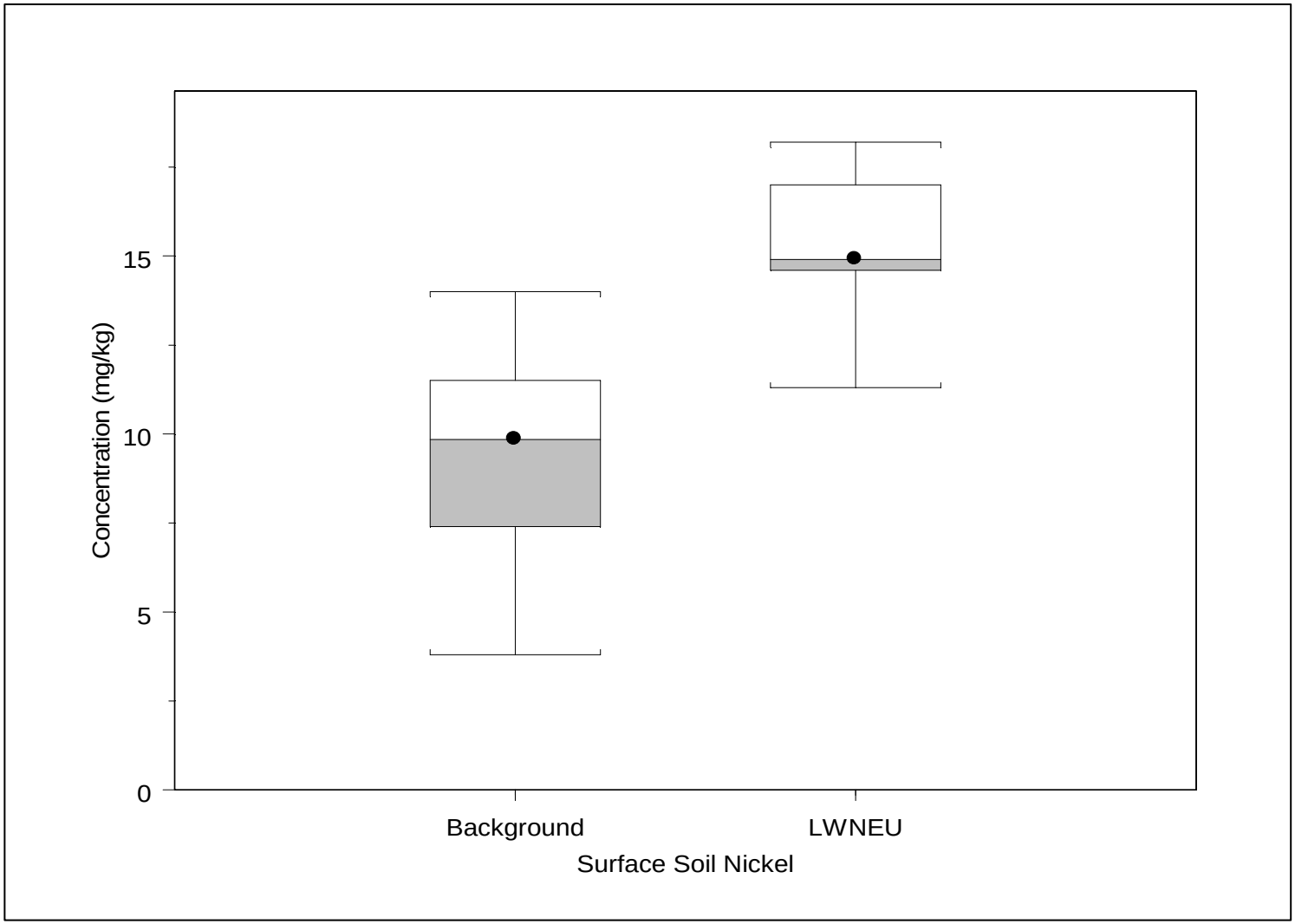
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.18
LWNEU Surface Soil Box Plots for Nickel



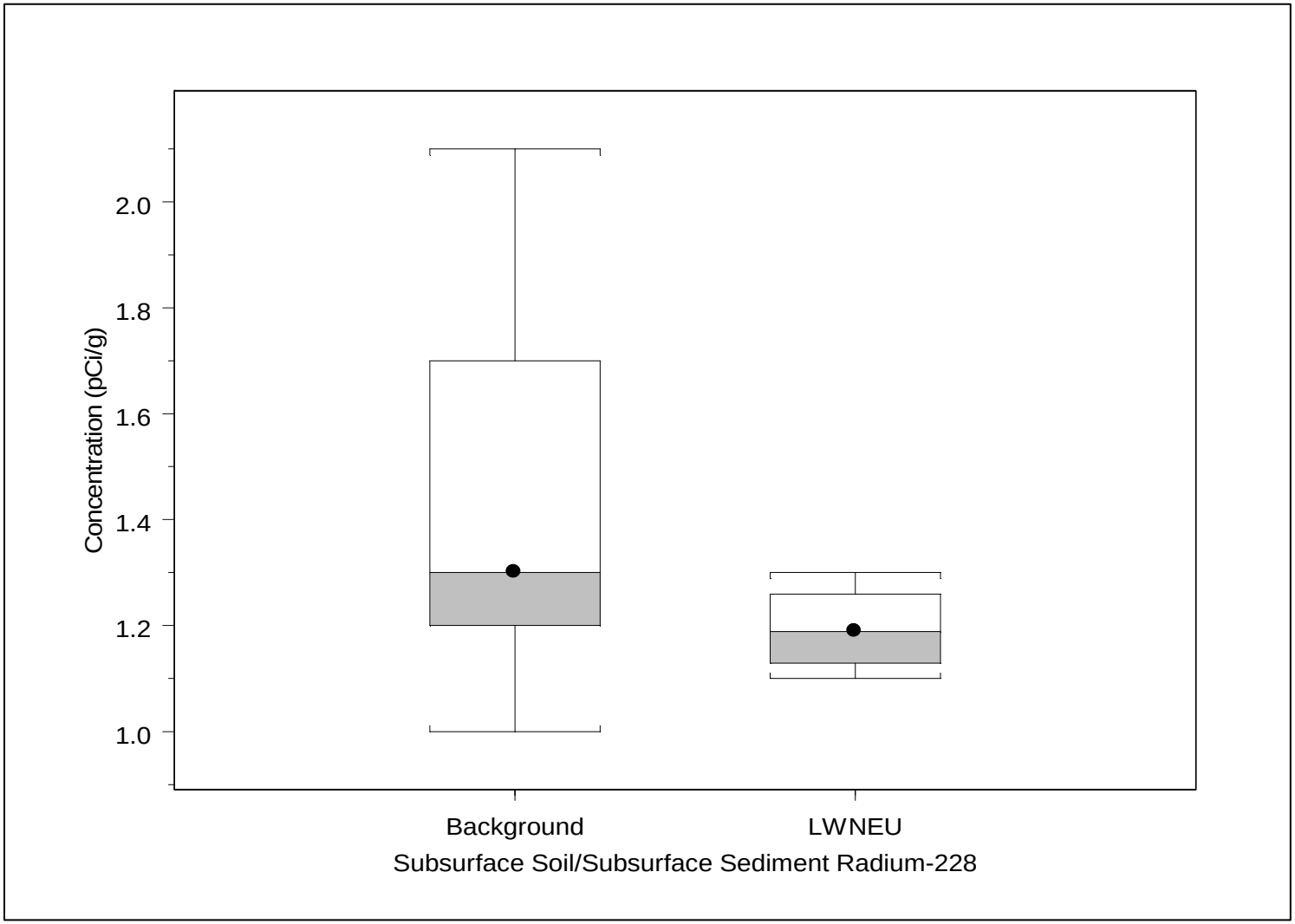
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.19
LWNEU Surface Soil Box Plots for Nickel (PMJM)



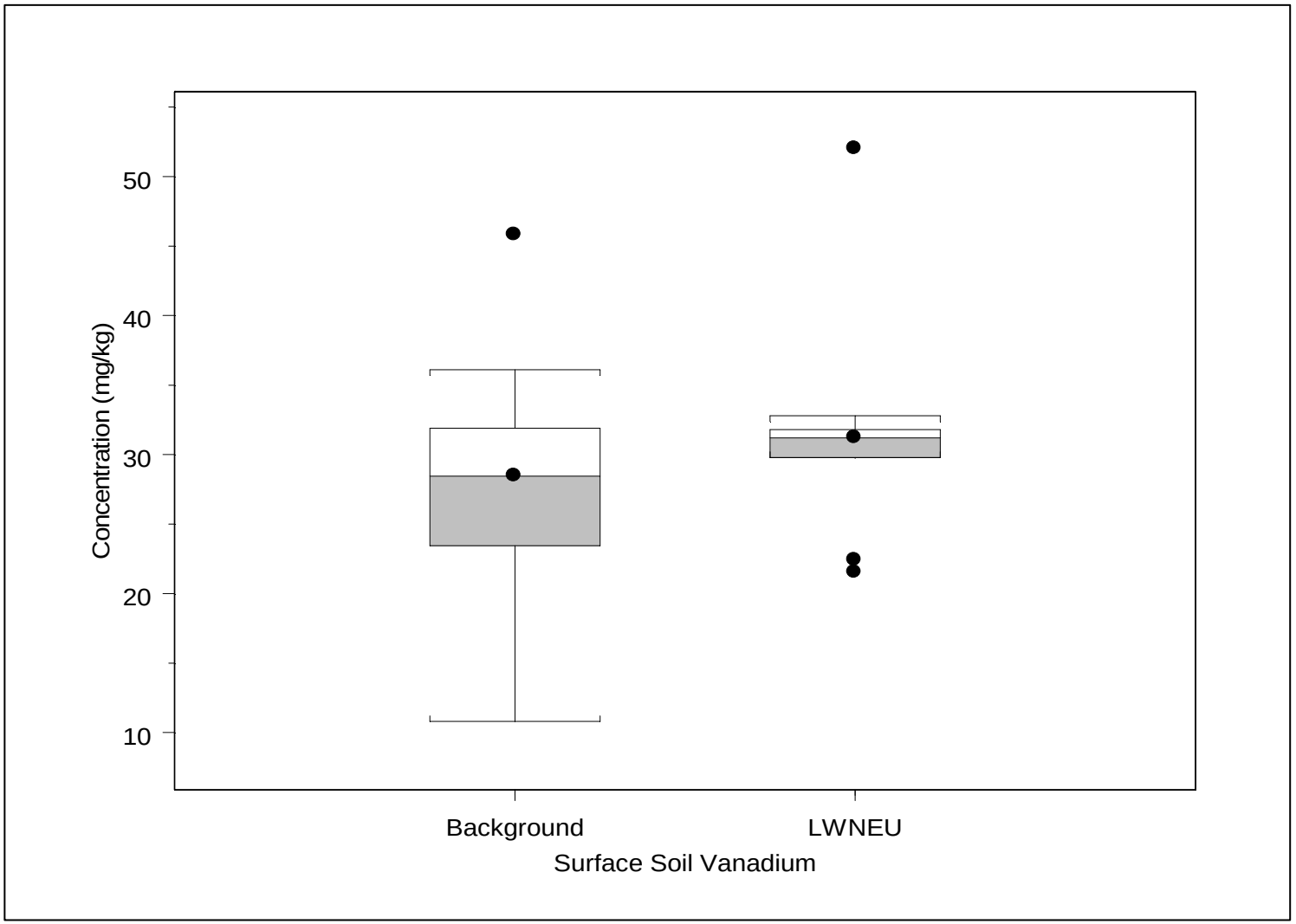
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.20
LWNEU Subsurface Soil/Subsurface Sediment Box Plots for Radium-228



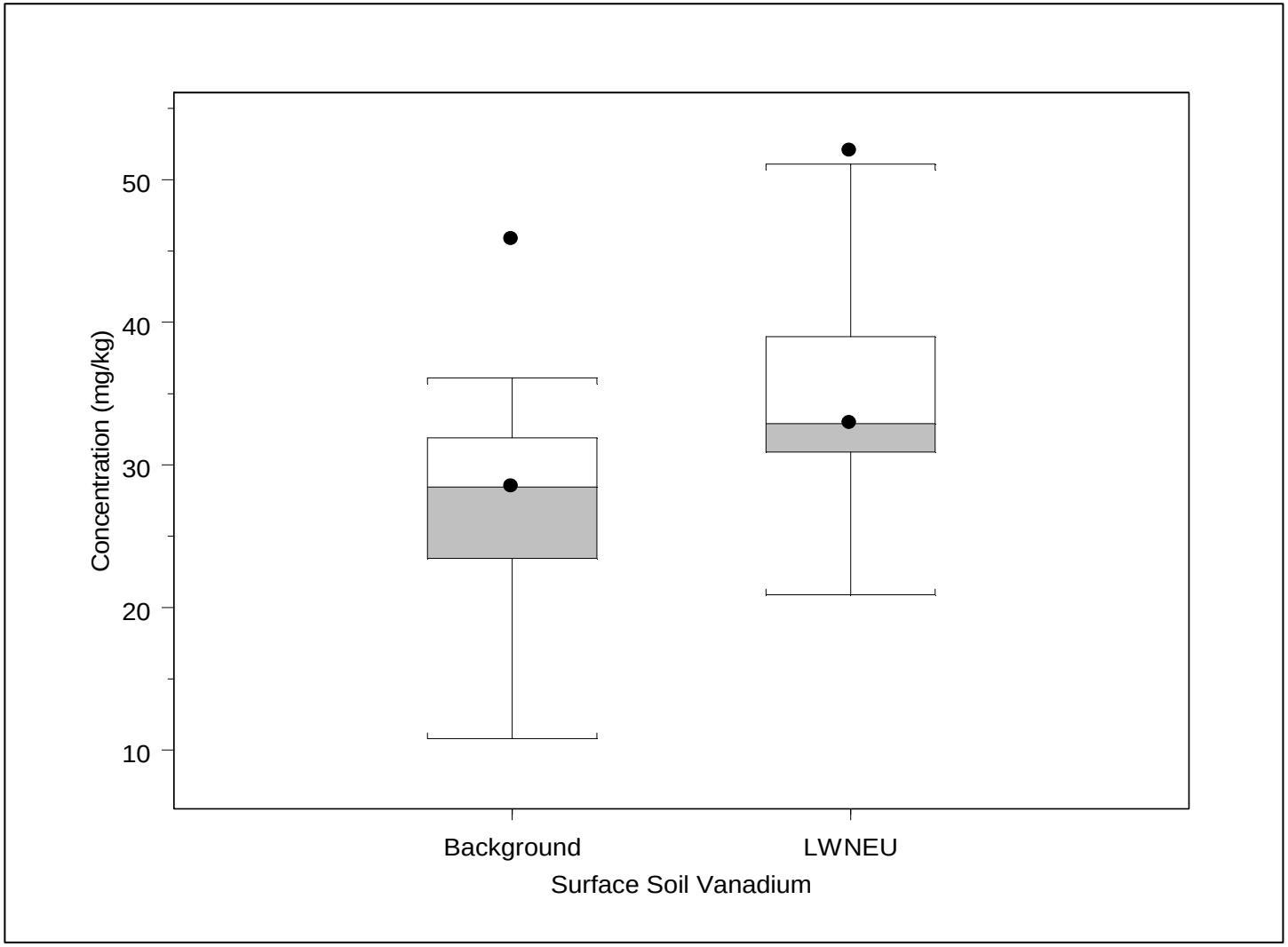
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.21
LWNEU Surface Soil Box Plots for Vanadium



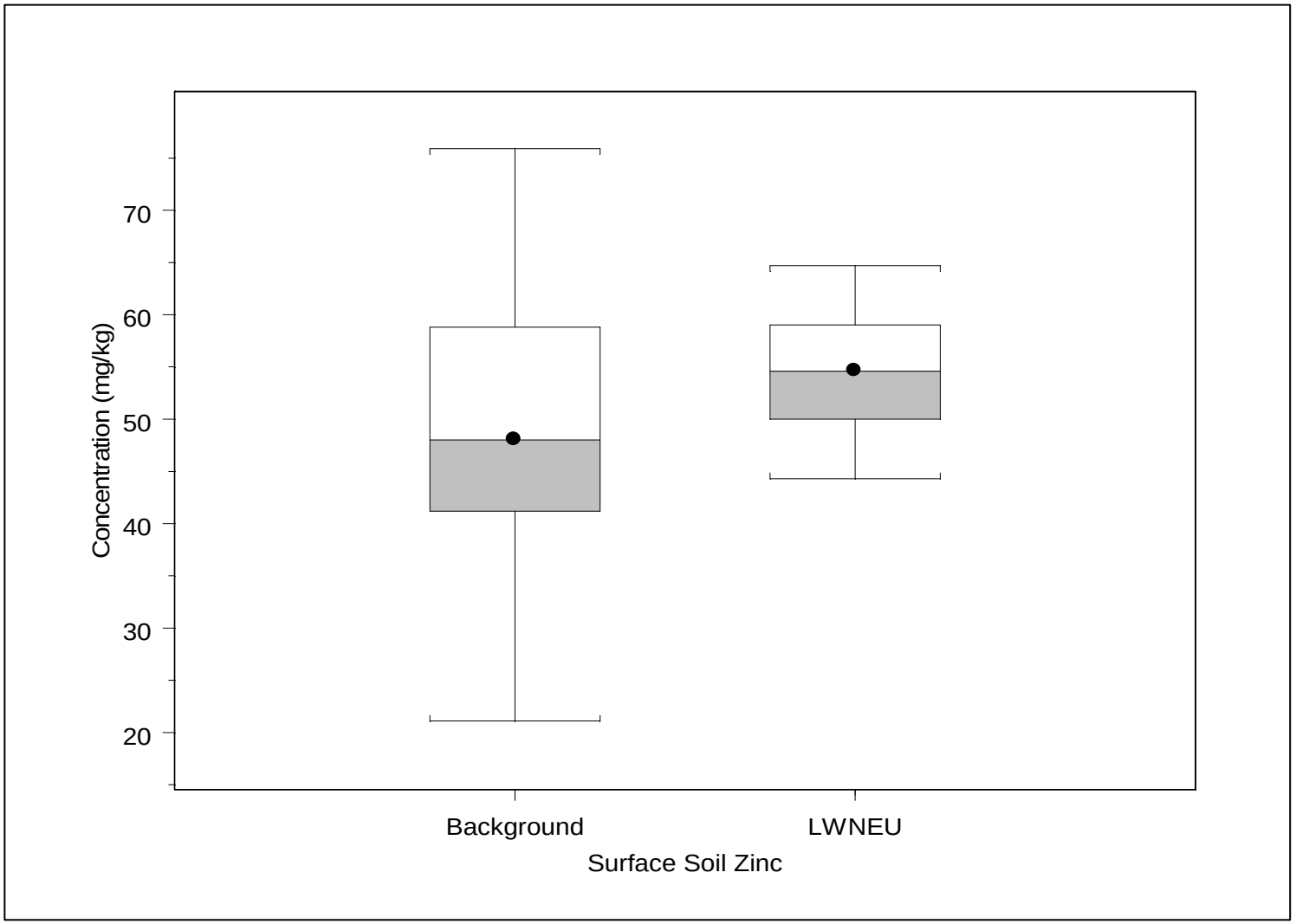
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.22
LWNEU Surface Soil Box Plots for Vanadium (PMJM)



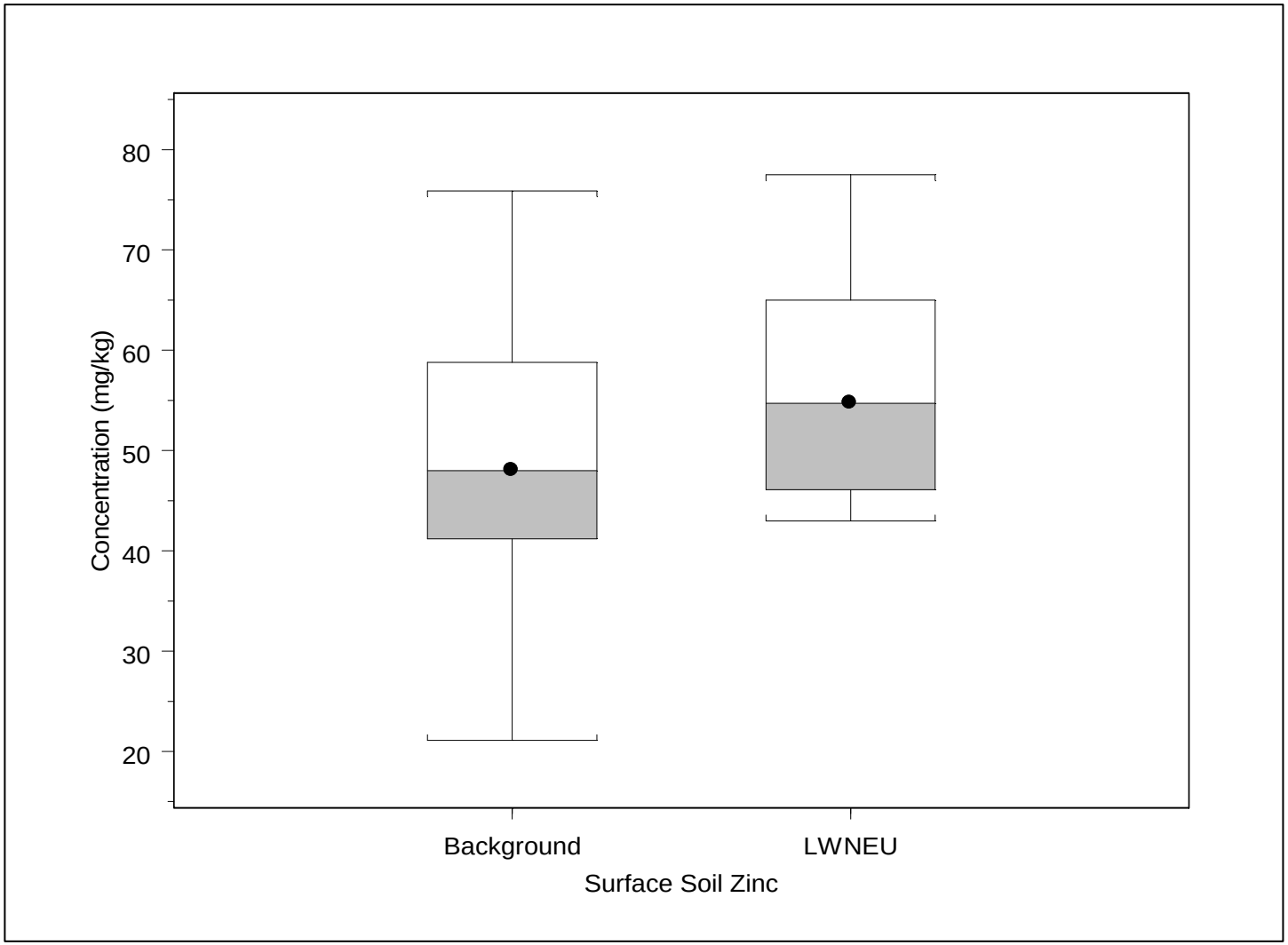
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.23
LWNEU Surface Soil Box Plots for Zinc (PMJM)



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.24
LWNEU Surface Soil Box Plots for Zinc



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

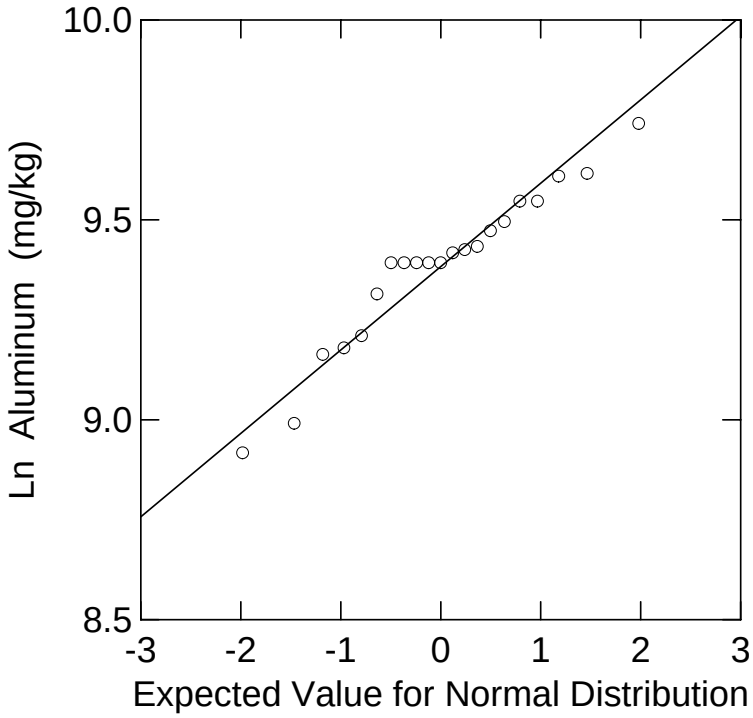


Figure A3.4.1. Probability Plot for Aluminum Concentrations (Natural Logarithm) in LWNEU Surface Soil

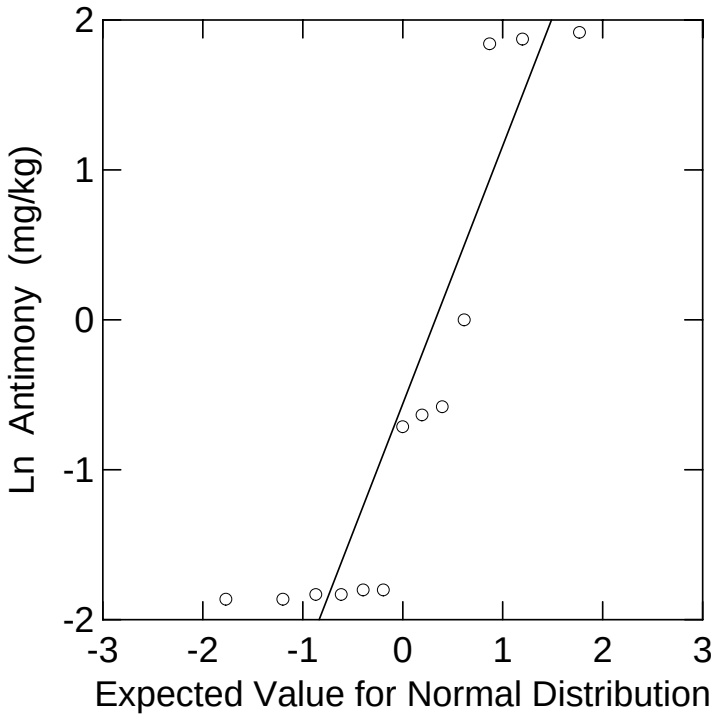


Figure A3.4.2. Probability Plot for Antimony Concentrations (Natural Logarithm) in LWNEU Surface Soil

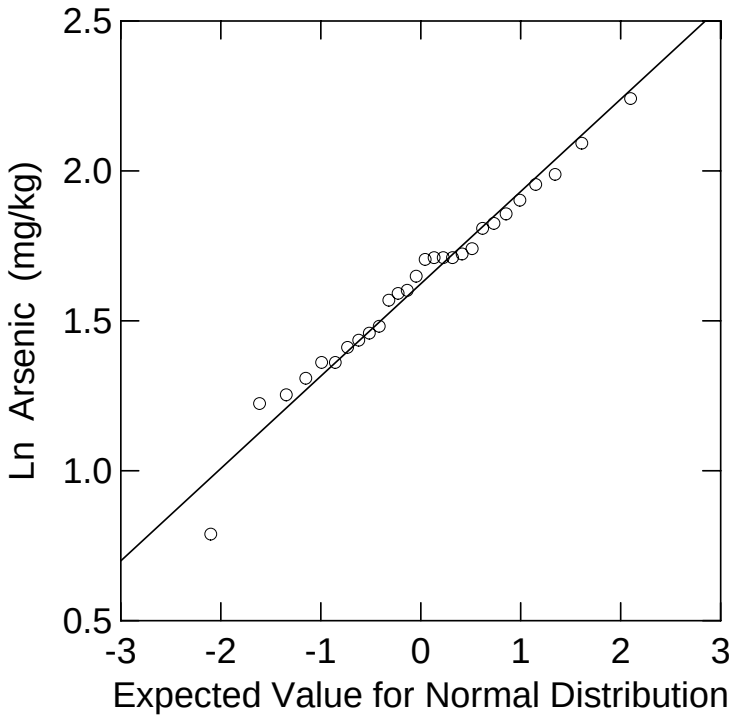


Figure A3.4.3. Probability Plot for Arsenic Concentrations (Natural Logarithm) in LWNEU Surface Soil/Surface Sediment

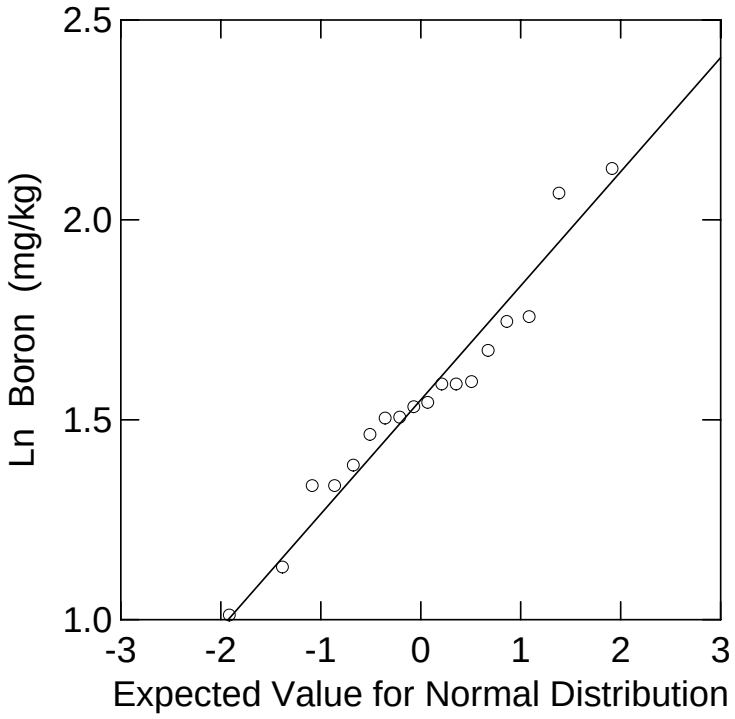


Figure A3.4.4. Probability Plot for Boron Concentrations (Natural Logarithm) in LWNEU Surface Soil

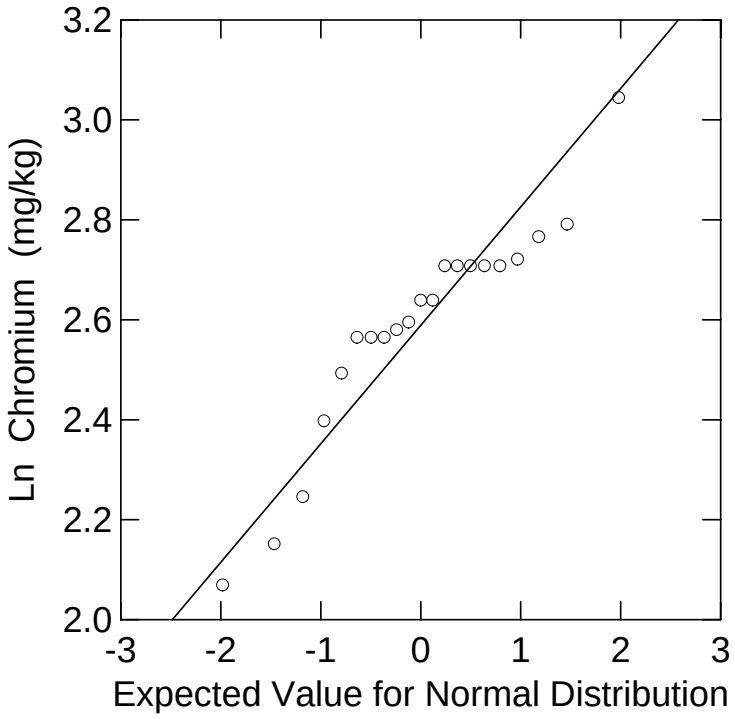


Figure A3.4.5. Probability Plot for Chromium Concentrations (Natural Logarithm) in LWNEU Surface Soil

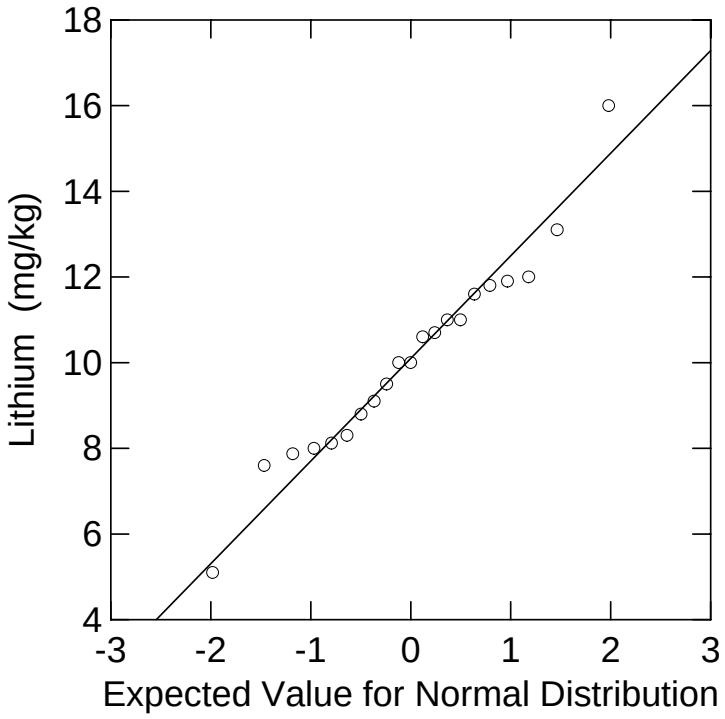


Figure A3.4.7. Probability Plot for Lithium Concentrations (Natural Logarithm) in LWNEU Surface Soil

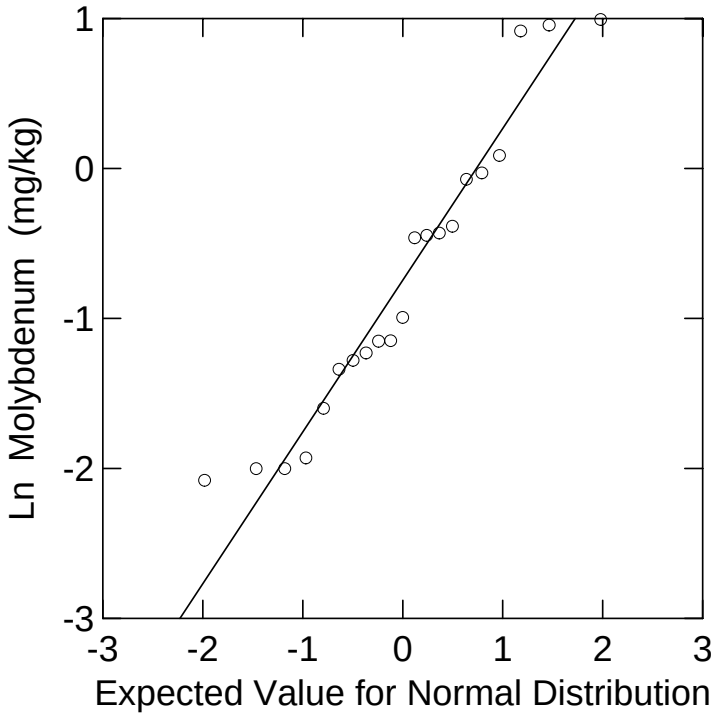


Figure A3.4.8. Probability Plot for Molybdenum Concentrations (Natural Logarithm) in LWNEU Surface Soil

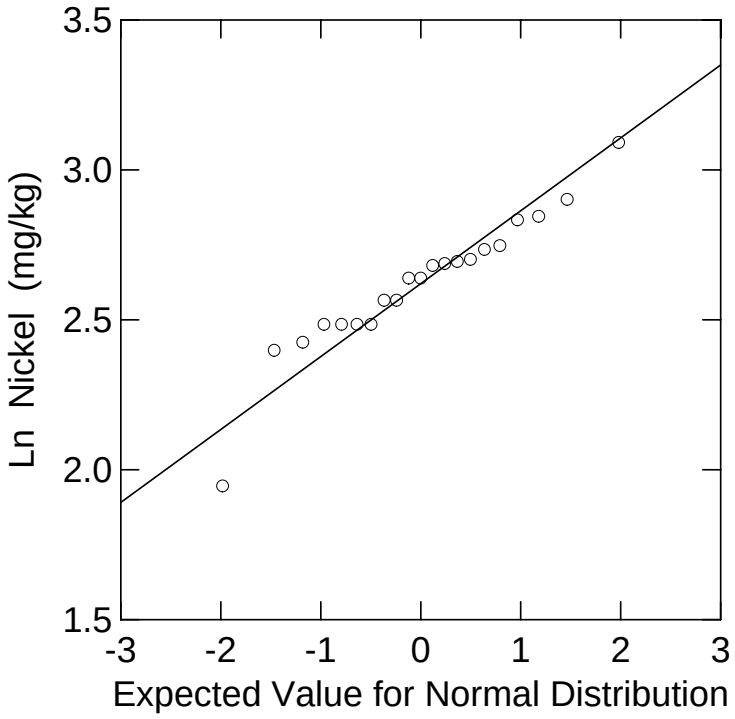


Figure A3.4.9. Probability Plot for Nickel Concentrations (Natural Logarithm) in LWNEU Surface Soil

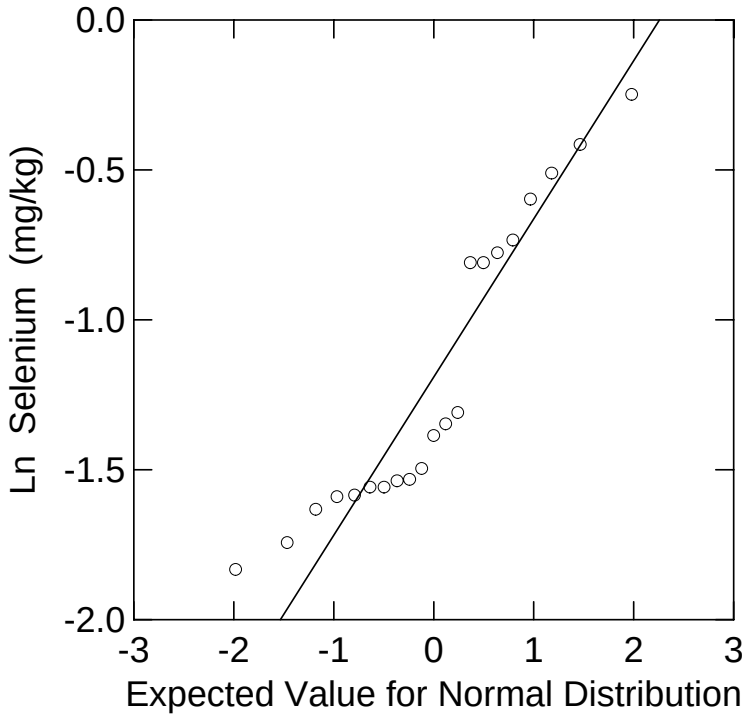


Figure A3.4.11. Probability Plot for Selenium Concentrations (Natural Logarithm) in LWNEU Surface Soil.

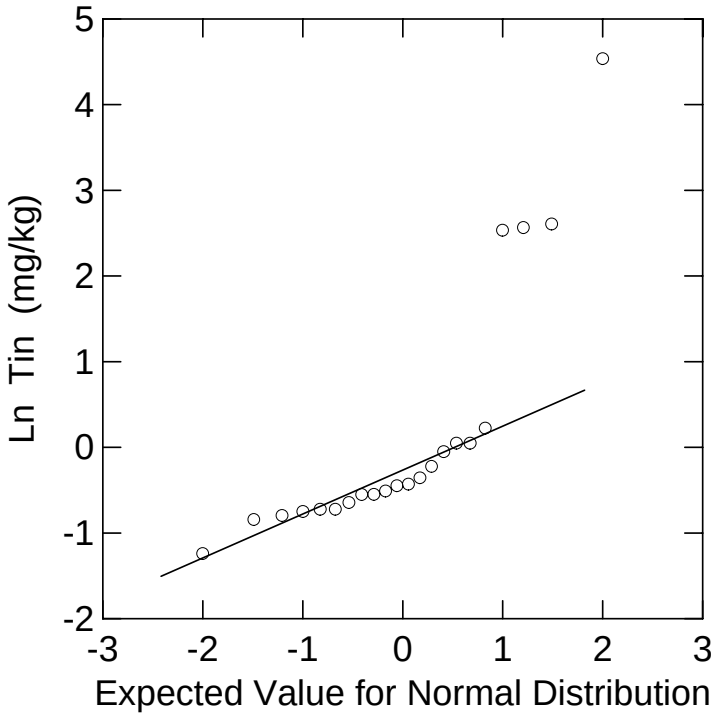


Figure A3.4.12. Probability Plot for Tin Concentrations (Natural Logarithm) in LWNEU Surface Soil

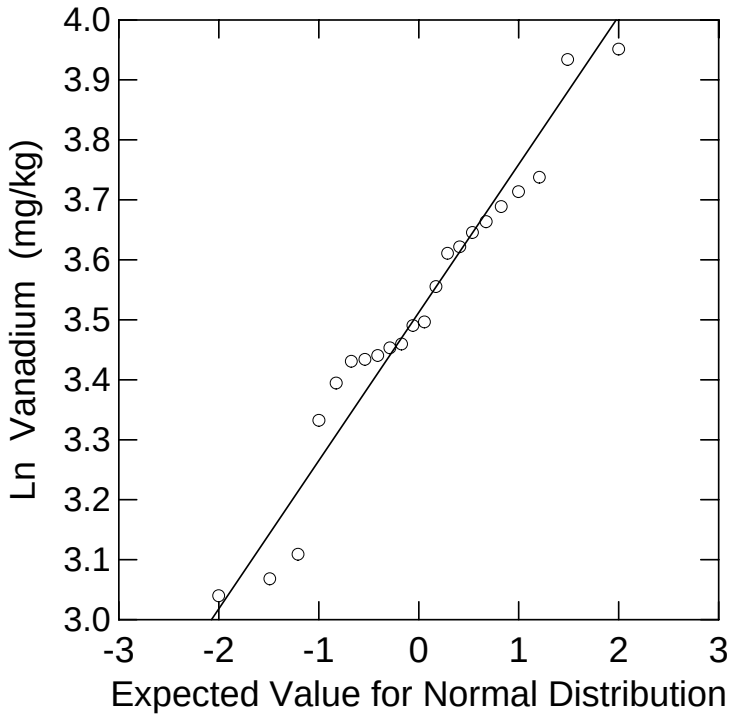


Figure A3.4.13. Probability Plot for Vanadium Concentrations (Natural Logarithm) in LWNEU Surface Soil

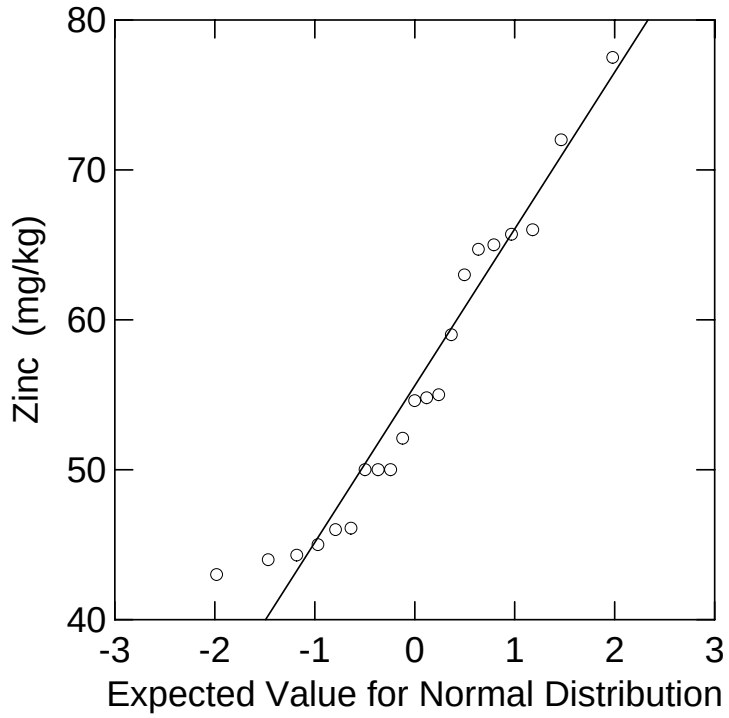


Figure A3.4.14. Probability Plot for Zinc Concentrations (Natural Logarithm) in LWNEU Surface Soil

COMPREHENSIVE RISK ASSESSMENT

LOWER WALNUT DRAINAGE EXPOSURE UNIT

VOLUME 8: ATTACHMENT 4

Risk Assessment Calculations

TABLE OF CONTENTS

1.0 ECOLOGICAL RISK ASSESSMENT TABLES

Table A4.2.1
Non-PMJM Intake Estimates for 4,4'-DDT - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
0.0800	32.4	28.5				
Media Concentrations (mg/kg)						
Soil Concentration	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**	
0.0260	Tier 1 UTL[a]	0.00208	0.842	0.740	0	
0.0235	Tier 1 UCL	0.00188	0.761	0.669	0	
0.0260	Tier 2 UTL[b]	0.00208	0.842	0.740	0	
0.0235	Tier 2 UCL	0.00188	0.761	0.669	0	
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	**$IR_{(water)}$ (kg/kg BW day)**	**$IR_{(soil)}$ (kg/kg BW day)**	**P_{plant}**	**P_{invert}**	**P_{mammal}**
Mourning Dove - Insectivore	0.230	0.120	0.0214	0	1	0
American Kestrel	0.0920	0.120	0.00460	0	0.200	0.800
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Mourning Dove - Insectivore						
Tier 1 UTL[a]	N/A	0.194	N/A	5.56E-04	0	0.194
Tier 1 UCL	N/A	0.175	N/A	5.03E-04	0	0.176
Tier 2 UTL[b]	N/A	0.194	N/A	5.56E-04	0	0.194
Tier 2 UCL	N/A	0.175	N/A	5.03E-04	0	0.176
American Kestrel						
Tier 1 UTL[a]	N/A	0.0155	0.0544	1.20E-04	0	0.0701
Tier 1 UCL	N/A	0.0140	0.0492	1.08E-04	0	0.0633
Tier 2 UTL[b]	N/A	0.0155	0.0544	1.20E-04	0	0.0701
Tier 2 UCL	N/A	0.0140	0.0492	1.08E-04	0	0.0633

[a]Tier 1 UTL was greater than the MDC, so the MDC was used as the proxy exposure point concentration to calculate intake.

[b]Tier 2 soil UTL was greater than the maximum grid average, or could not be calculated due to low numbers of samples, so the maximum grid average was used as a proxy exposure point concentration to calculate intake.

N/A = Not applicable or not available.

Table A4.2.2
Hazard Quotients for Surface Soils in the LWNEU - 4,4'-DDT

Exposure Point Concentration	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)		Hazard Quotients	
		NOAEL	LOAEL	NOAEL	LOAEL
4,4'-DDT (Default Exposure Scenario)					
Mourning Dove - Insectivore					
Tier 1 UTL[a]	0.194	0.009	1.50	**22**	0.1
Tier 1 UCL	0.176	0.009	1.50	**20**	0.1
Tier 2 UTL[b]	0.194	0.009	1.50	**22**	0.1
Tier 2 UCL	0.176	0.009	1.50	**20**	0.1
American Kestrel					
Tier 1 UTL[a]	0.0701	0.009	1.50	**8**	0.05
Tier 1 UCL	0.0633	0.009	1.50	**7**	0.04
Tier 2 UTL[b]	0.0701	0.009	1.50	**8**	0.05
Tier 2 UCL	0.0633	0.009	1.50	**7**	0.04

[a]Tier 1 UTL was greater than the MDC, so the MDC was used as the proxy exposure point concentration to calculate intake.

[b]Tier 2 soil UTL was greater than the maximum grid average, or could not be calculated due to low numbers of samples, so the maximum grid average was used as a proxy exposure point concentration to calculate intake.

Bold = Hazard quotients>1.

COMPREHENSIVE RISK ASSESSMENT

LOWER WALNUT DRAINAGE EXPOSURE UNIT

VOLUME 8: ATTACHMENT 5

Chemical-Specific Uncertainty Analysis

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

BAF	bioaccumulation factor
CMS	Corrective Measures Study
CRA	Comprehensive Risk Assessment
DOE	U.S. Department of Energy
ECOI	ecological contaminant of interest
ECOPC	ecological contaminant of potential concern
Eco-SSL	ecological soil screening level
EPA	U.S. Environmental Protection Agency
HQ	hazard quotient
LOAEL	lowest observed adverse effect level
NOAEL	no observed adverse effect level
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
TRV	toxicity reference value

1.0 INTRODUCTION

One potential limitation of the hazard quotient (HQ) approach is that calculated HQ values may sometimes be uncertain due to simplifications and assumptions in the underlying exposure and toxicity data used to derive the HQs. Where possible, this risk assessment provides information on two potential sources of uncertainty, described below.

- **Bioaccumulation Factors (BAFs).** For wildlife receptors, concentrations of contaminants in dietary items were estimated from surface soil using uptake equations. When the uptake equation was based on a simple linear model (e.g., $C_{tissue} = BAF * C_{soil}$), the default exposure scenario used a high-end estimate of the BAF (the 90th percentile BAF). However, the use of high-end BAFs may tend to overestimate tissue concentrations in some dietary items. In order to estimate more typical tissue concentrations, where necessary, an alternate exposure scenario calculated total chemical intake using a 50th percentile (median) BAF and HQs were calculated. The use of the median BAF is consistent with the approach used in the ecological soil screening level (Eco-SSL) guidance (U.S. Environmental Protection Agency [EPA] 2005).
- **Toxicity Reference Values (TRVs).** The Comprehensive Risk Assessment (CRA) Methodology (U.S. Department of Energy [DOE] 2005) used an established hierarchy to identify the most appropriate default TRVs for use in the ecological contaminant of potential concern (ECOPC) selection. However, in some instances, the default TRV selected may be overly conservative with regard to characterizing population-level risks. The determination of whether the default TRVs are thought to yield overly conservative estimates of risk is addressed in the uncertainty sections below on a chemical-by-chemical basis in the following subsections. When an alternate TRV is identified, the chemical-specific subsections provide a discussion of why the alternate TRV is thought to be appropriate to provide an alternative estimate of toxicity (e.g., endpoint relevance, species relevance, data quality, chemical form, etc.), and HQs were calculated using both default and alternate TRVs where necessary.

The influences of each of these uncertainties on the calculated HQs are discussed for each ECOPC in the following subsections.

1.1 4,4'-DDT

Bioaccumulation Factors

Both invertebrate and small mammal tissue concentrations for 4,4'-DDT were estimated using uptake models based on the log K_{ow} of 4,4'-DDT. As cited in the CRA Methodology, if organic ecological contaminants of interest (ECOIs) with no empirically calculated BAFs available in the first two sources, log K_{ow} equations are used (as presented and modified in the EPA Eco-SSL [EPA 2003]). These values are more uncertain than empirically based BAFs and are likely to overestimate tissue concentrations to an unknown degree. This uncertainty is compounded in the soil-to-

small mammal BAF that uses both the soil-to-invertebrate and soil-to-plant (also log K_{ow}-based) BAFs to estimate the diet of the small mammal. A second model is then used to estimate the amount of ECOI transferred from prey food to prey tissues. This compounded uncertainty may overestimate the concentrations of 4,4'-DDT by an even larger degree than was noted for the soil-to-invertebrate pathway.

Toxicity Reference Values

Appendix B of the CRA Methodology presents a no observed adverse effect level (NOAEL) and a lowest observed adverse effect level (LOAEL) TRV for avian effects from 4,4'-DDT. However, the NOAEL was estimated from the LOAEL. As such, it does not reflect a laboratory measured value. Given the uncertainty in the NOAEL TRV, the risks calculated using the NOAEL may be either overestimated or underestimated to an unknown degree. The LOAEL was based on observed increases in adverse reproductive effects in mallards. The confidence placed in this value was high. No alternative TRVs are recommended.

Background Risk Calculations

4,4'-DDT was not analyzed for in background surface soils. Therefore, background risks were not calculated for 4,4'-DDT in Appendix A, Volume 2, Attachment 9 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation/Corrective Measures Study (CMS)-Feasibility Study (RI/FS) Report (hereafter referred to as the RI/FS Report).

2.0 REFERENCES

U.S. Department of Energy (DOE), 2005. Final Comprehensive Risk Assessment Work Plan and Methodology, Rocky Flats Environmental Technology Site, Golden, Colorado. September.

U.S. Environmental Protection Agency (EPA), 2003. Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs). OSWER 9285.7-55. Office of Solid Waste and Emergency Response. December.

EPA, 2005. Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs). Attachment 4-1 Update. Office of Solid Waste and Emergency Response. February.

COMPREHENSIVE RISK ASSESSMENT

LOWER WALNUT DRAINAGE EXPOSURE UNIT

VOLUME 8: ATTACHMENT 6

CRA Analytical Data Set